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QUALITY INTEGRATED WORK PLAN FOR THE CONTINUOUS AND FILTER AIR QUALITY MEASUREMENTS IN THE CALIFORNIA REGIONAL $PM_{10}/PM_{2.5}$ AIR QUALITY STUDY (CRPAQS)

STI-999214-1921-QIWP

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Prepared for:
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Note: The QIWP was not updated for the Winter Intensive period; accurate operating information can be found in the STI CRPAQS Anchor Site Measurements and Operations Report (Wittig A.E. et al., 2003)

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LIST OF ACRONYMS

ADI	Aerosol Dynamics, Inc.
ALT	Altamont Pass Site
ANG	Angiola Site
BAC	Bakersfield Site
BOC	Bakersfield Operations Center
BOD	Bodega Bay Site
BTI	Bethel Island Site
CE-CERT	University of California at Riverside, College of Engineering-Center for the Environment and Technology
CRPAQS	California Regional $PM_{10}/PM_{2.5}$ Air Quality Study
DAS	Data acquisition systems
DM	Data Manager, Mr. Dan Spuckler
DMC	Data Management Center
DQSR	Data quality summary reports
DRI	Desert Research Institute
EDW	Edwards Air Force Base Site
IOP	Intensive Operating Periods
LQL	Lower quantifiable limit
M14	Modesto 14th Street Site
PI	Principal Investigator, Dr. Donald Blumenthal
PM	Project Manager, Mr. Lyle Chinkin
QA	Quality Assurance
QC	Quality Control
SDP	Sacramento Del Paso Manor Site
SJ4	San Jose 4th Street Site
SNF	Sierra Nevada Foothills Site
STI	Sonoma Technology, Inc.
TC	Technical Coordinator, Dr. Paul Roberts
WAG	Walnut Grove Site

1. PROJECT PLANNING AND ORGANIZATION

1.1 INTRODUCTION

Sonoma Technology, Inc. (STI) is participating in the air quality monitoring phase of the "California Regional PM_{10}/$PM_{2.5}$ Air Quality Study" (CRPAQS). Annual air quality data for the study will be obtained during a 14-month field program (from December 1, 1999, through February 3, 2001) by a combination of full-scale "anchor" monitoring sites measuring both gaseous and aerosol species, supplemental "satellite" sites measuring aerosol species using portable monitors, and a "backbone" network of existing California Air Resources Board (ARB) and air pollution control district sites. Intensive field measurements will be made during fall and winter-like conditions when PM_{10} and $PM_{2.5}$ concentrations are highest.

STI is responsible for the anchor-sites and for the delivery of data from these sites of known precision, accuracy, and validity, with over 90% data recovery on the required schedule. The location of the anchor sites is illustrated in **Figure 1-1**. STI will operate an annual, anchor site network consisting of four locations: the Bakersfield (BAC) site, the Angiola ground (ANG) and tower (ANG1, ANG50, and ANG100) sites, the San Jose (SJ4), and Sacramento (SDP) site. The BAC and ANG sites are considered 'core' sites and have extensive instrumentation as shown in **Table 1-1**. The SDP and SJ4 sites have more limited instrumentation, also shown in Table 1-1. The Desert Research Institute (DRI) will operate the anchor site at Fresno. In addition to the annual anchor site network, STI will operate a winter anchor site network consisting of five locations: the Sierra Nevada Foothills (SNFH) site, the Bethel Island (BTI) site, the Walnut Grove ground (WAG) and tower (WAGT) sites, and the Bodega Bay site. The instrument and operating specifications for the various measurements made at the STI-operated sites are summarized in **Table 1-2**. Appendix A contains the Standard Operating Procedures (SOPs) and other technical information for the instruments operated by STI staff at the CRPAQS Anchor sites. Appendix B contains a table of data quality objectives.

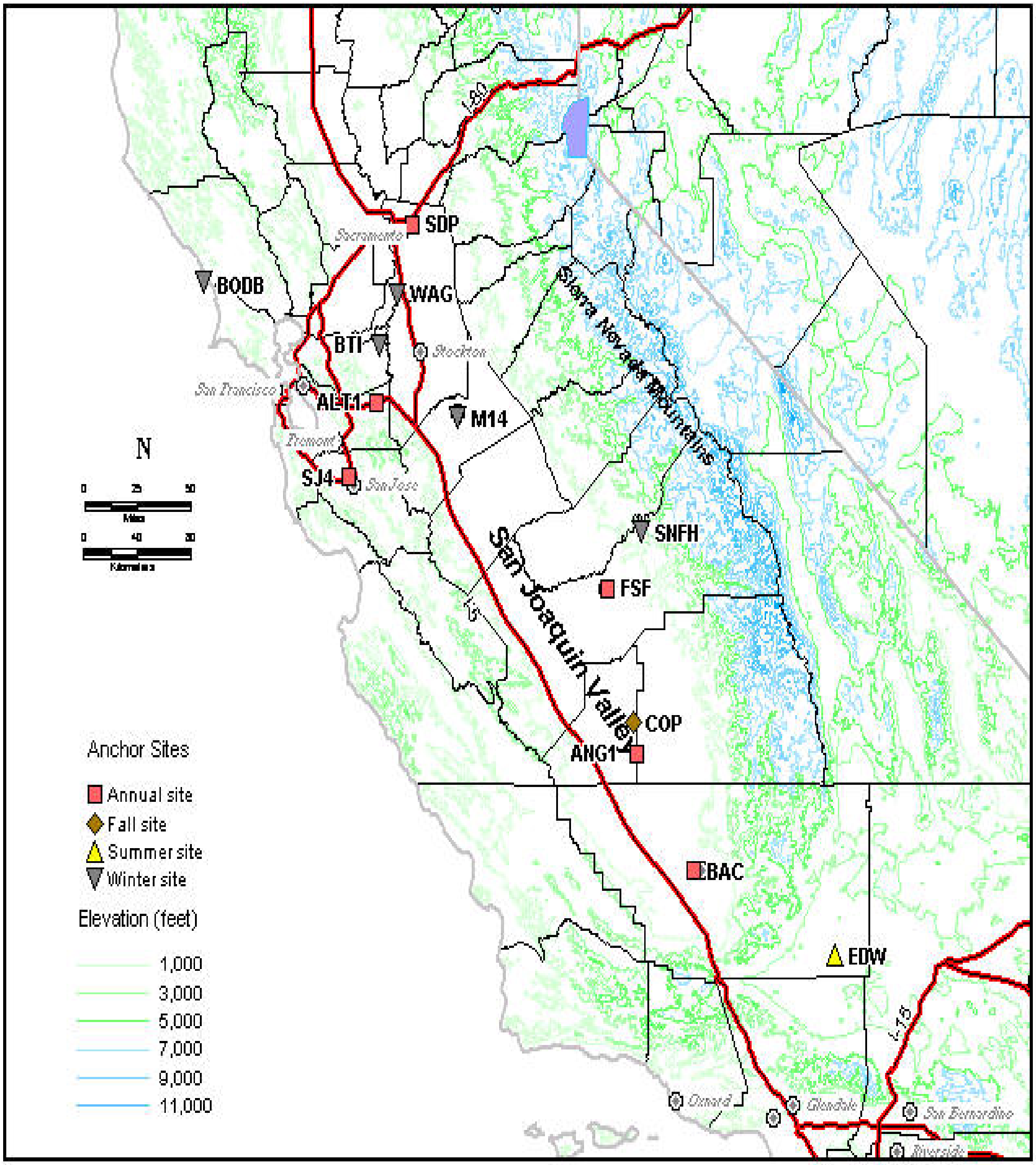

Figure 1-1. Anchor site locations.

Table 1-1. Parameters measured at CRPAQS anchor sites.

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ID	Measured Parameter	ALT	ANG	ANG1	ANG50	ANG95	BAC	BOD	BTI	COP	EDW	M14	SDP	SJ4	SNF	WAG	WGT
A	PM_{10} Light Scattering	A[d]	A	A	A	A	A	A[d]	A[d]	F[d], W[d]	A[d]	W[d]	A	A	A[d]	A[d]	W
B	$PM_{2.5}$ Mass, Elements, Ammonia (Minivol with Teflon, Cellulose filter & G, XRF, AC)[e]	A[d]						A[d]	A[d]	A[d]	A[d]	A[d]			A[d]		
C	$PM_{2.5}$ Ions, Carbon, Nitric Acid (Minivol with Quartz, Cellulose filter & IC, AC, TOR, AA)[e]							A[d]	A[d]	A[d]	A[d]	A[d]			A[d]		
D	$PM_{2.5}$ Organic Compounds (Minivol with Glass Fiber & GC/MS)[e]		A[d]				A[d]		A[d]	A[d]	A[d]	A[d]	A[d]	A[d]	A[d]		
G-1	$PM_{2.5}$ Black Carbon (1-wavelength)[a]		A[c]				A[c]	W			S	W	A[c]	A[c]		W	W
G-2	$PM_{2.5}$ Black Carbon (7-wavelength)[b]		F, W			W	F, W		W	F			F, W	F, W	W		
H	$PM_{2.5}$ Organic & Elemental Carbon		A				A										
I-1	PM_{10} Coarse Particle Sizing (Climet OPC)		A		A	A											
I-2	PM_{10} Medium Particle Sizing (PMS OPC)		A														
I-3	PM_{10} Fine Particle Sizing (TSI SMPS)		A														
J	PM_{10} Total Mass		A				A			F	S						
K	$PM_{2.5}$ Total Mass	A	A				A		W	F	S		A	A	W		
L	$PM_{2.5}$ Mass & Elements (SFS with Teflon filter)[e]		A				A		W						W		
M	$PM_{2.5}$ Ions & Carbon (SFS with denuder-quartz-NaCI cellulose)[e]		A				A		W						W		
O	NO_y		A			W	A		W						W		

[a] $PM_{2.5}$ Black Carbon @ 880nm.
[b] $PM_{2.5}$ Black Carbon @ 950nm, 880nm, 660nm, 590nm, 571nm, 450nm, 350nm.
[c] These instruments were replaced with 7-wavelength $PM_{2.5}$ Black Carbon instruments.
[d] These instruments were not operated by STI. Their measurements were collected and reported by a different contributor.
[e] AA = Atomic absorption, AC = Automated colorimetry, FID = Flame ionization detector, G = Gravimetry, GC = Gas chromatography, IC = Ion chromatography, MS = Mass spectroscopy, TOR = Thermal optical reflectance, XRF = X-ray flourescence.

Table 1-1. Parameters measured at CRPAQS anchor sites.

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ID	Measured Parameter	ALT	ANG	ANG1	ANG50	ANG95	BAC	BOD	BTI	COP	EDW	M14	SDP	SJ4	SNF	WAG	WGT
P	O_3		A			W									W		
Q	$PM_{2.5}$ Nitrate		F, W			W	F, W		W	F				W	W	W	W
R	HNO_3		W												W		
T	$PM_{2.5}$ Sulfate		W				W										
U	Light Hydrocarbons (canister & GC/FID) [e]		W					A [d]	W						W		
V	Heavy Hydrocarbons (TENAX&GC/TSD/FID) [e]		W						W						W		
W	$PM_{2.5}$ Organic Compounds (Teflon coated glass fiber/ PUF/XAD&GC/MS) [e]		W						W						W		
X	Aldehydes (DNPH & HPLC) [e]		W						W						W		
Y	SO_2						W										
b	PAN/NO_2		W				F, W		W						W		
c	Ion Size Distribution (MOUDI with aluminum & TOR) [e]		W														
d	Carbon Size Distribution (MOUDI with aluminum & TOR) [e]		W														
e	Aerosol Time of Flight MS		W [d]														
g	PM_{10} Mass, Elements, Ammonia (Minivol with Teflon, Cellulose filter & G, XRF, AC) [e]									A [d]		A [d]					
h	PM_{10} Ions, Carbon, Nitric Acid (Minivol with Quartz, Cellulose filter & IC, AC, TOR, AA) [e]									A [d]		A [d]					
i	TSP Denuder HNO_3 (SGS with Quartz filter & IC) [e]		W												W		
j	$PM_{2.5}$ Denuder NH_3 (SGS with Quartz filter & AC) [e]		W												W		
DAS	Data acquisition system		A				A	W	W	F	S	W	A	A	W	W	W

[a] $PM_{2.5}$ Black Carbon @ 880nm.
[b] $PM_{2.5}$ Black Carbon @ 950nm, 880nm, 660nm, 590nm, 571nm, 450nm, 350nm.
[c] These instruments were replaced with 7-wavelength $PM_{2.5}$ Black Carbon instruments.
[d] These instruments were not operated by STI. Their measurements were collected and reported by a different contributor.
[e] AA = Atomic absorption, AC = Automated colorimetry, FID = Flame ionization detector, G = Gravimetry, GC = Gas chromatography, IC = Ion chromatography, MS = Mass spectroscopy, TOR = Thermal optical reflectance, XRF = X-ray flourescence.

Table 1-2. Continuous measurements and methods.

ID	Measured Parameter	Vendor/Model	Method	Averaging Time (min)	Measurement Expert
A	PM_{10} Light Scattering	Radiance Research M903 Nephelometer	Visible light scattering	5	Richards
G-1	$PM_{2.5}$ Black Carbon (1-wavelength)	Andersen Instruments AE1X Aethalometer	Light absorption @ 880nm	5	Alcorn
G-2	$PM_{2.5}$ Black Carbon (7-wavelength)	Andersen Instruments AE3X Aethalometer	Light absorption @ 950nm, 880nm, 660nm, 590nm, 571nm, 450nm, 350nm	5	Wittig
H	$PM_{2.5}$ OC/EC Carbon	Rupprecht & Patashnick 5400 OC/EC	Thermal plateau vaporization of CO_2	60	Wittig
I-1	PM_{10} Coarse Particle Sizing	Climet Instruments Spectro.3 CI-500 OPC	Optical particle sizing and counting	5	Hering
I-2	PM_{10} Medium Particle Sizing	Particle Measuring Systems Lasair OPC	Optical particle sizing and counting	5	Hering
I-3	PM_{10} Fine Particle Sizing	TSI SMPS	Scanning mobility particle sizing and counting	5	Hering
J	PM_{10} Total Mass	Met One Instruments 1020 BAM	Beta ray attenuation	60	Wittig
K	$PM_{2.5}$ Total Mass	Met One Instruments 1020 BAM	Beta ray attenuation	60	Wittig
O	NO_y	Thermo Environmental Instruments 42CY NO_y	Chemiluminescence with single external converter	1	Fitz
P	O_3	Advanced Pollution Instrumentation 400A O_3	UV absorption at 254nm	1	Wittig
Q	$PM_{2.5}$ Nitrate	Rupprecht & Patashnick 8400N Nitrate	Thermal flash vaporization of NO_x	10	Hering
R	$HN0_3$	Thermo Environmental Instruments Dual Converter 42CY HNO_3	Chemiluminescence with dual external converters	1	Fitz
T	$PM_{2.5}$ Sulfate	Rupprecht & Patashnick 8400S Sulfate	Thermal flash vaporization of SO_2	10	Hering
Y	SO_2	Thermo Environmental Instruments 43S SO_2	Pulsed UV fluorescence at 294nm	1	Wright
b	$PANNO_2$	CECERT PAN/NO_2	Continuous luminol with chromatography	1	Fitz

Table 1-3. Non-continuous PM measurements and methods.

ID	Measured Parameter	Collection Method	Analysis Method	Sample schedule [a]
L	$PM_{2.5}$ Mass & Elements	DRI SFS with Teflon filter		Annual daily, Winter IOP
M	$PM_{2.5}$ Ions & Carbon	DRI SFS with denuder-quartz-NaCl cellulose		Annual daily, Winter IOP
U	Light Hydrocarbons	OGI Canister	GC/FID	Winter IOP
V	Heavy Hydrocarbons	DRI TENAX	GC/TSD/FID	Winter IOP
W	$PM_{2.5}$ Organic Compounds	DRI Teflon coated glass fiber/PUF/XAD	GC/MS	Winter IOP
X	Aldehydes	AtmAA DNPH	HPLC	Winter IOP
c	Ion Size Distribution	DRI MOUDI with Teflon	IC, AC	Winter IOP
d	Carbon Size Distribution	DRI MOUDI with Aluminum	TOR	Winter IOP
i	Denuder HNO_3	DRI SGS with Quartz	IC	Winter IOP
j	Denuder NH_3	DRI SGS with Quartz	AC	Winter IOP

[a] Annual daily samples are collected for 24h; Winter IOP samples are collected on the schedules summarized in Table 2-3.

1.2 BACKGROUND

CRPAQS is a multi-year program of meteorological and air quality monitoring, emission inventory development, data analysis, and air quality simulation modeling (Watson et al, 1998). Please refer to the field plan for additional information (Watson et al, 1999).

1.3 PROJECT SCOPE AND WORK OBJECTIVES

1.3.1 CRPAQS Objectives

1. Provide an improved understanding of emissions and the dynamic atmospheric processes that influence particle formation and distribution,

2. Develop and demonstrate methods useful to decision makers in formulation and comparing candidate control strategies for attaining the federal and state $PM_{10}/PM_{2.5}$ standards in central California, and

3. Provide reliable means for estimating the impacts of control strategy options developed for $PM_{10}/PM_{2.5}$ on visibility, air toxics, and acidic aerosols and on attainment strategies for other regulated pollutants, notably ozone.

Meeting these objectives requires an extensive, high-quality air quality and meteorology database. STI is responsible for providing the air quality database for the anchor sites.

1.3.2 Anchor Site Air Quality Measurement Objectives

STI anchor site air quality measurement objectives are described in detail in the field plan and in Section 1.4 of this QIWP. Key objectives were identified for the following categories:

- Project management

- Installation of field equipment
- Field operations
- Data acquisition
- Data communication
- Data quality control

1.3.3 Participating Organizations

To meet the anchor site air quality measurement objectives and provide an extensive, well-organized air quality database, STI has assembled a team of contractors with experience, capabilities, and facilities for all the required activities. Our team includes experts with extensive experience with the required measurements, who will ensure that the measurement systems are set up and operating properly and are obtaining high quality data. The contractors and their responsibilities follow.

Sonoma Technology, Inc. (STI)

STI will be the prime contractor and will be responsible for overall project management; all field installations and field operations (assisted by Fields Tower Systems for Angiola tower instruments); data management; report and plan preparation; and preparation, setup, and installation of several instruments and the data acquisition systems. STI will also provide staff to assist Aerosol Dynamics, Inc. (ADI) in the preparation, setup, and installation of the equipment for which ADI is responsible; and STI will coordinate the installation of measurement systems on the towers. Dr. Donald Blumenthal of STI will be the Principal Investigator (PI) for the anchor-site measurements.

For each measurement, an expert in that measurement will be responsible for input to the Quality-Integrated Work Plan (QIWP); development of the standard operating procedures (SOPs), calibration, and quality control (QC) procedures; coordination of the preparation, setup, and installation of the measurement systems; training of the field staff for that instrument; suggestion of data-review criteria; periodic review of selected data to ensure the instruments are working properly; and input to the Data Quality Summary Reports and the Field Summary Report. The measurement experts will be assisted in their tasks by the staffs of their organizations and by other co-contractors. The instrument responsibilities for each measurement expert are listed below.

Desert Research Institute (DRI)

Dr. Judy Chow: sequential filter samplers (SFS), Sequential Gas Samplers (SGS), and Mico-orifice uniform deposit impactors (MOUDIs)

Dr. Barbara Zielinska: heavy hydrocarbon and $PM_{2.5}$ organic measurements

Aerosol Dynamics, Inc. (ADI)

Dr. Susanne Hering: continuous particle-size, $PM_{2.5}$ nitrate, and $PM_{2.5}$ sulfate instruments

Sonoma Technology, Inc. (STI)

Dr. L. Willard Richards: nephelometers and aethalometers

Dr. Paul Roberts: continuous PM_{10} and $PM_{2.5}$ mass instruments

Dr. Beth Wittig: ozone instrument, continuous organic and elemental carbon instruments

Center for Environmental Research and (CE-CERT)

Mr. Dennis Fitz: NO_y, HNO_3, and PAN/NO_2 instruments

Oregon Graduate Institute (OGI)

Dr. Rei Rasmussen: light hydrocarbon measurements

AtmAA, Inc.

Dr. Kochy Fung: aldehydes measurements

1.4 PROJECT DESCRIPTION

Objectives were identified for several key phases of the project. By fulfilling these objectives, STI will be able to provide a high-quality database of anchor site air quality measurements.

1.4.1 Project Management

- Ensure that project milestones are met. This objective will be met by the PI by managing and overseeing the overall project, monitoring and evaluating the performance of the project, and interacting with the CRPAQS management team.
- Ensure that technical activities are performed. This objective will be met by the Technical Coordinator (TC), Dr. Paul Roberts, by coordinating instrument selection and setup and training activities, and by overseeing the field operations, laboratory, and data management activities, each of which will have its own manager. The field operations will be managed by the STI Field Manager, Dr. Beth Wittig, who will reside in the Bakersfield Operations Center (BOC). The laboratory activities will be managed by the DRI PI and Co-PI, and the data management activities will be managed at STI by the STI data manager, Ms. Hilary Main.
- Ensure that the project is performed within the limitations of the contract and budget. This objective will be met by the Project Manager (PM), Mr. Lyle Chinkin, by monitoring progress on milestones and by assisting the PI and TC in resolving schedule and budget problems. The PM will be assisted by an Administrative Assistant and the STI Contracts Manager.

1.4.2 Installation of Field Equipment

- Install and make operational all measurement equipment. This objective will be met with the assistance of subcontracted measurement experts and experienced setup contractors.
- Provide field technicians to maintain and troubleshoot field equipment.

1.4.3 Field Operations

- Identify, plan, and manage the routine and 'as needed' tasks and schedules for field operations at the anchor sites.
- Manage the activities of the anchor site field technicians.
- Provide field support for periodic operational checks and QC procedures, reviewing automatic calibration data, performing periodic maintenance, reviewing data for unusual circumstances, performing filter and substrate changes, documenting and storing samples, maintaining chain of custody forms, transferring samples to the Bakersfield operations center for shipping to laboratories, performing periodic full calibrations, performing instrument repairs and swaps, and relieving the other site operators during their off days.
- Manage, archive, and maintain an electronic chain of custody database for all CRPAQS filters.
- Share filter shipping, filter sample storage, and nephelometer and Minivol maintenance duties at select sites with T&B Systems.
- Operate the instruments as described in the SOPs in Appendix A of this report.

1.4.4 Data Acquisition and Communication

- Ensure the proper operation of field equipment by communicating with the site data acquisition system daily, by summarizing and reviewing auto zero and span data, and by initiating corrective action as necessary.
- Obtain level 1A archive continuous data from each field site by downloading data on a daily basis to the STI data center, quality controlling the data according to protocols developed by the measurement experts, applying final calibrations, and adjusting the data if necessary.
- Provide preliminary data plots for review on a restricted web site.

1.4.5 Data Quality Control Activities

- Provide a quality-controlled database of continuous measurements. This objective will be met by performing routine automated zero/span checks; periodic full calibrations; maintenance of detailed logbooks for each instrument; chain of custody forms; blanks and replicate samples; daily review of auto zero/span checks and sampling data; Level 1A QC of data; operation in accordance with this QIWP, the included SOPs (Appendix A) , and a Health and Safety Plan (HASP); quality audits (QAs) by an independent audit contractor and additional data QA by the CRPAQS data manager (DM).
- Provide for quality-controlled filter measurements. This objective will be met by identifying all filters packs and substrates with a unique barcode label; refrigerating all filters prior to and after sampling; maintaining field data sheets as a chain of custody form; recording filter shipping in a Shipping Logbook, in a computerized Project Status Sheet (PJS), and an Air Analysis Logbook.

1.5 PERSONNEL QUALIFICATIONS

The team of STI personnel and “measurement experts” subcontracted by STI includes individuals with experience, capabilities, and facilities to achieve the CRPAQS anchor site air quality measurement objectives. **Figure 1-2** illustrates the organizational structure of the project. The measurement experts will be assisted in their tasks by the staffs of their organizations. **Figure 1-3** illustrates the organizational structure of the fieldwork.

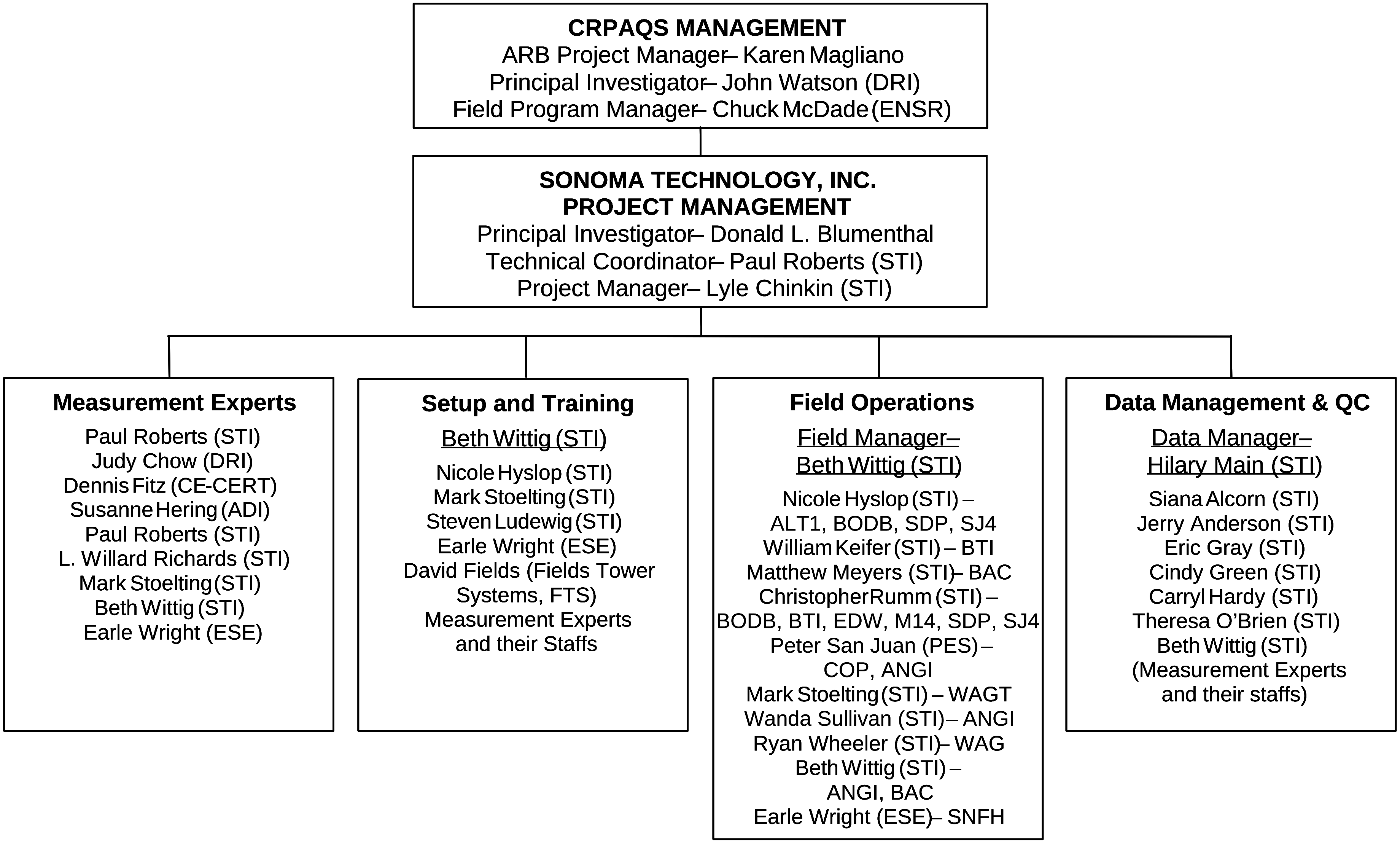

Figure 1-2. Organizational structure of project and key participants.

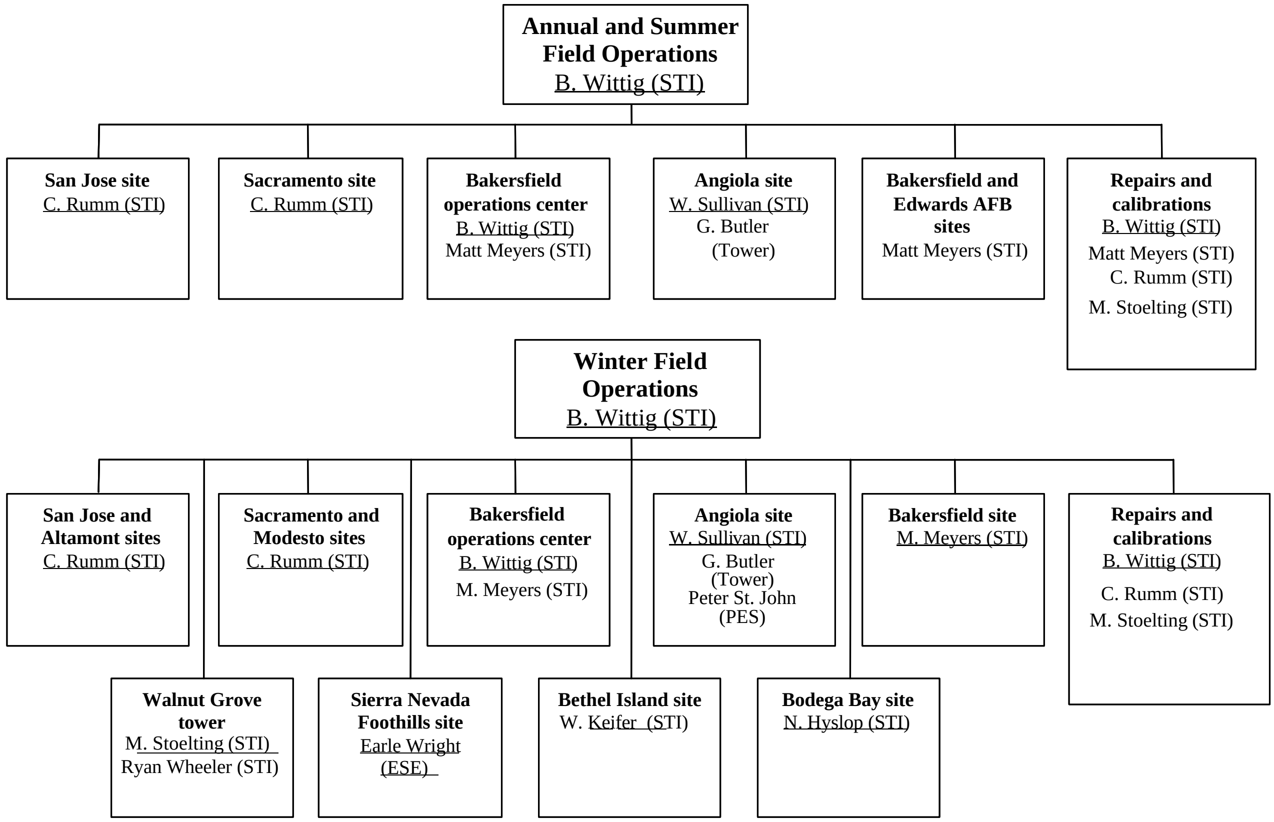

Figure 1-3. Field operations organizational structure.

1.6 TRAINING REQUIRED

Once the sites are prepared by the JPA, we will install the instruments and conduct on-site training of the site operators to enable them to perform their measurements. Key areas of training will include:

- Operating principles and instrument configuration,
- Flow calibrations and leak checks,
- Preventive and corrective maintenance,
- Use of spreadsheets to document and communicate site activities,
- Basic troubleshooting procedures for instrument malfunctions, and
- Health and safety issues related to the monitoring operations.

Once each instrument is installed, it will undergo a full calibration by the on-site operator with the help of the measurement expert or setup contractor.

1.7 COMMUNICATION PLAN

1.7.1 Internal Communications Plan

The FOC will be the focal point for operational issues and problems. Beth Wittig will be responsible for reporting any recurrent or unresolved instrument, site, or field personnel issues to the TC and PI. Together, they will make decisions on returning instruments, changing operating procedures, and making personnel adjustments.

The site operators are responsible for reporting any instrument malfunctions or irregularities to the FOC within eight hours after the problem is identified. The Database Technician, Ms. Cindy Green, will perform daily data quality-control operations and will provide daily updates, by e-mail, to the FOC, TC, PI, and site operators. The site operators are responsible for reviewing these updates and attempting to resolve any problems.

When instrument, communications, or computer problems are experienced, there are several resources available to the site operators. Depending on the type and complexity of the problem encountered, the site operator may choose to consult other Site Operators, the Database Technician, and/or the Instrument Expert. The respective instrument expert should be consulted when an unresolvable or reoccurring problem is experienced with any of their instruments. Table x-x lists the contact information for the STI team.

If the operator is successful at solving the problem, the operator should inform the FOC and Database Technician that the problem was resolved. If the operator is unsuccessful at solving the problem within a few hours, they should consult FOC.

The site operators will complete daily site logs, which document any instrument problems, routine maintenance checks, observed instrument interferences, and/or DAS problems. These logs will be faxed to FOC and Database Technician on a daily basis excluding weekends.

The FOC, PI, and TC will conduct a conference call on a weekly basis. These conference calls will be used to discuss the status of the field operations, any on-going or unresolved instrument problems, personnel issues, and planning.

1.7.2 Data Communication Plan

Compatible data acquisition systems will be used at all sites and will interface with all continuous measurement equipment in a consistent manner. The data acquisition systems will allow access from STI or from the site to upload data, download new software, and control instrument functions.

The data acquisition systems will include a computer with a Pentium processor, zip or similar removable media, a hard disk sufficient to store several months of data, serial and/or USB ports, analog-to-digital converter boards, digital inputs, and calibrator relay controls as needed. The same basic systems with various levels of software and hardware modules will be used at all the sites. The data formats will be consistent among sites, and data will easily be downloaded to STI or other locations as needed. A single consistent data interface at all sites will greatly simplify data access, processing, and troubleshooting.

Automated data uploads from each site to the data management center (DMC) computer at the STI Petaluma office will be performed nightly. The data acquisition system at each site will be programmed to call STI and upload the data file on a nightly basis. A three-day running data file will be uploaded to the DMC each night. The sites will have staggered upload times to avoid busy signals. Polling problems due to storms, telephone line damage, and computer outages are inevitable; however, the PC-based polling system will allow for on-demand polling of all site data whenever needed.

The data will be automatically loaded into a relational database for processing and validation. Space is allowed in the database for estimates of precision and validation flags for individual data values.

The on-site data will also be available to the site operators who will be trained to screen the data for unusual events as part of their routine activities. Operation of non-continuous instruments will be monitored during each site visit, which will be at least twice weekly for the core sites and the winter anchor sites.

1.7.3 External Communication Plan

Dr. Donald Blumenthal, the Principal Investigator (PI), will have the overall responsibility for performance of the project and for interactions with the CRPAQS management. He will work with the CRPAQS PI, Program Manager, and Field Manager to resolve conflicts and problems as they arise.

The Data Manager (DM) for the continuous measurements is Ms. Hilary Main of STI. The Data Manager for the laboratory measurements is Dr. Judy Chow of DRI. Data will be submitted in five increments during the project. The laboratory data will be submitted directly by DRI. The continuous data will be submitted directly by STI. Data submittals will cover the following periods:

- 12/1/1999 through 2/29/2000
- 3/1/2000 through 5/31/2000
- 6/1/2000 through 8/31/2000
- 9/1/2000 through 11/30/2000
- 12/1/2000 through 1/31/2001

Data for each period will be submitted approximately seven months after the end of the period. The CRPAQS data manager will perform Level 1B QC of the submitted data. When issues are found during audits or when data problems are identified, we expect to be notified rapidly so that we can take corrective action.

At the end of the measurement period, several reports will be submitted to the CRPAQS Field Manager. STI will prepare field and data management summary reports. These reports will summarize the field and data validation activities associated with the Anchor site operations. They will include descriptions of field sampling sites and equipment, laboratory analysis techniques, unusual events encountered in the field, and periods of suspect data. In addition to the activities reports, Data Quality Summary Reports (DQSR) will be submitted for each major measurement type. These reports will summarize the completeness, accuracy, precision, and the lower quantifiable limit (LQL) for each measurement over the entire study period.

The anticipated recipients of authorized information are

- Dr. John Watson, CRPAQS Principal Investigator
  DRI, Sage Building, Stead Facility
  2215 Raggio Parkway
  Reno NV 89512-1095
  (702) 677-3166
- Ms. Karen Magliano, CRPAQS Project Manager
  California Air Resources Board
  PO Box 2815
  Sacramento, CA 95812
  (916) 322-7137
- Mr. Dave Bush, CRPAQS Quality Assurance Manager
  AVES
  50 East Foothill Boulevard
  Arcadia, CA 91006
  (530) 642-2398
- Mr. Chuck McDade, CRPAQS Field Manager
  ENSR Consulting and Engineering
  1220 Avenida Acaso
  Camarillo, CA 93012
  (805) 388-3775

2. MANAGEMENT ASSESSMENT AND AUDITS

2.1 ASSESSMENT RESPONSIBILITY

Both internal and external management assessments will be performed for CRPAQS. STI employees, subcontracted measurement experts and the external CRPAQS Audit team will all have responsibilities for various assessment activities. Several STI employees will have internal assessment responsibilities: the STI Site Operators, the STI Field Manager, and the STI Technical Coordinator. The measurement experts subcontracted by STI and the External Audit CRPAQS Team will have external assessment responsibilities.

Internal assessment responsibility chain of command

- STI Site Operators
- STI Data Technician
- STI Field Technician
- STI Field Manager
- STI Technical Coordinator

External assessment responsibility chain of command

- STI Subcontracted Measurement Experts
- External CRPAQS Audit Team

2.2 ASSESSMENT TYPES

Both internal and external management assessments will be performed for CRPAQS. The STI Site Operators, the STI Field Manager, and the STI Technical Coordinator will perform the internal assessments on a daily to monthly basis. The measurement experts subcontracted by STI and the External Audit CRPAQS Team will perform the external assessments on a less frequent basis.

2.2.1 Internal Assessment Responsibility Chain of Command

STI Site Operators

- Maintaining site and instrument lab books.
- Reviewing nightly zero/span calibration checks.
- Performing and reviewing the calibrations and audits according to the procedures established in the QIWP and SOPs.
- Resolving issues raised in audits, calibrations, daily data reviews, and monthly data report reviews by the Field Manager and Technical Coordinator.

STI Data Technician

- Reviewing data from all anchor sites on a daily basis.
- Sending e-mails to all STI participants with descriptions of any irregularities/problems with the data and/or data communications.
- Reviewing site and instrument logbooks weekly to resolve data problems.
- Maintaining a log of data problems and how they were resolved.

STI Field Manager

- Coordinating and documenting the daily project QC activities.
- Ensuring project QC activities (audits and calibrations) established in the QIWP and SOPs are being followed.
- Seeing that issues raised during project QC activities are resolved.
- Reviewing site and instrument lab books.

STI Technical Coordinator

- Reviewing project QC activities (audits, calibrations, and resolution of problems).
- Working with the external CRPAQS audit team to schedule, perform, and resolve any potential problems.

2.2.2 External Assessment Responsibility Chain of Command

STI Subcontracted Measurement Experts

- Peer reviewing the data and project QC activities (audits, calibrations, and resolution of problems) in first month to establish that the procedures in the QIWP and SOPs are adequate and are being properly followed out.
- Documenting the findings of the preliminary audit and any modifications that were made to the QIWP and SOPs as a result of these findings.

External CRPAQS Audit Team

- Working with the STI internal assessment team to perform periodic external audits according to the external audit schedule.
- Documenting the findings and resolution (if any) of the periodic external audits.

2.3 ASSESSMENT USAGE

<u>Internal assessment usage</u>

Internal assessments will be used to ensure that the precision and accuracy goals of the instruments are being met on a daily, monthly, and quarterly basis. The Field Technician and Field Manager will ensure that any problems identified while performing daily reviews, routine maintenance, or quarterly calibrations by the STI Site Operators are resolved. The communications and procedures for addressing these problems are described in Sections 1.7 and 1.8.

<u>External assessment usage</u>

The measurement experts subcontracted by STI will perform an external peer review of the data and project QC activities (audits, calibrations, and resolution of problems) in the first month. This external assessment will be used to establish that the procedures defined in the QIWP and SOPs allow the data precision and accuracy goals to be met for each measurement. The measurement experts will refine the procedures in the QIWP and SOPs to meet the precision and accuracy goals in this first month.

External assessments will also be used to ensure that the precision and accuracy goals of the instruments are being met on a periodic basis. The Field Technician and Field Manager will resolve any problems that are identified as a result of external audits.

2.4 ASSESSMENT CRITERIA

2.4.1 Internal Assessment Criteria

All internal assessments will be performed by the STI Site Operators, STI Field Technician, STI Field Manager, or STI Technical Coordinator. These individuals are all directly involved with the work. The STI Field Manager and STI Technical Coordinator both have technical expertise in the field. The STI Site Operators and Field Technician will be trained by the measurement experts to be proficient at the operation, maintenance, and troubleshooting of the instruments and will document daily activity on a site and instrument basis.

2.4.2 External Assessment (Measurement Expert) Criteria

- Reviewers/auditors are not directly involved with the work
- Reviewers/auditors have technical expertise in the field
- Reviewers/auditors are provided sufficient information about the work
- Results of the review/audit are documented

2.5 ASSESSMENT DOCUMENTATION

Several types of CRPAQS fieldwork assessment will be performed to facilitate data QC and validate the measurements throughout the course of the project.

- Site and instrument log book preparation by STI Field Technicians
- Site and instrument log books review by STI Field Manager
- QC activity review by measurement experts
- SOP revision by measurement experts
- External Audit Report preparation by CRPAQS Audit Team
- Data Quality Summary Reports

2.5.1 Logbooks

Site and instrument lab books will contain the following documentation:

- Date of each entry
- Name of the operator and/or note taker
- Serial number of the instrument and/or site name
- Description of any instrument checks performed
- Description of any instrument problems encountered
- Description of any instrument maintenance or repairs performed
- Details of any changes to instrument operating parameters
- Description of any unusual activities and/or measurement interferences that occurred at the site (such as idling vehicles, crop harvesting, yard work, construction, etc.)

2.5.2 Data Management and Data Quality Summary Reports (DQSRs)

The Data Management Report and DQSRs will cover each type of continuous measurement. DRI will prepare DQSRs for the filter measurements. The Data Management Report will contain the following pieces of information:

- Operating parameters for the instrument,
- Parameters measured by the instrument,
- Any regular or reoccurring measurement interferences encountered during the study,
- Any major or reoccurring instrument problems, and
- Criteria used to validate the data.

The Data Quality Summary Reports will contain the following pieces of information:

- Completeness, accuracy, precision, and the lower quantifiable limit (LQL) for each parameter measurement over the entire study period,
- Detailed descriptions of the methods used to calculate these measures, and
- Any operational changes that were implemented during the course of the study and any impacts these changes may have had on the data quality.

3. PROJECT IMPLEMENTATION

3.1 PROJECT RESPONSIBILITIES

3.1.1 Project Organizational Structure

The organizational structure for the project was presented in Figure 1-2. The senior management team for the project will include Dr. Donald Blumenthal as the Principal Investigator (PI), Dr. Paul Roberts as the Technical Coordinator (TC) and Quality Control (QC) Coordinator, and Mr. Lyle Chinkin as the Project Manager (PM). Dr. Blumenthal is CEO of STI, and Dr. Roberts and Mr. Chinkin are both Vice Presidents; so the project will have the ongoing attention of STI's top management.

- PI responsibilities
  - Overall performance of the project
  - Interactions with the CRPAQS management.
  - Work with the CRPAQS PI, Program Manager, and Field Manager to develop a final scope for the anchor site measurements.
  - Resolve conflicts and problems as they arise.
  - Monitor all phases of the project and ensure that the milestones are being met.
  - Participate in the activities of the TC and PM and will trade off with them as needed to ensure that a senior manager is always available for decision making and emergencies.
- TC responsibilities
  - Coordinate the ongoing technical activities of the project.
  - Work with the measurement experts, the Project and CRPAQS PIs, and the CRPAQS Field Manager to select and specify the options for the instruments to be used.
  - Coordinate the setup, testing, and training activities of the measurement experts and the setup contractors.
  - Oversee the field operations and data management activities.
  - Oversee preparation of the QIWP and final reports.
  - Coordinate the project QC activities.
  - Review the calibrations and audits and ensure that the QC activities established in the QIWP and SOPs are being followed.
  - See that issues raised in audits and calibrations and problems found in the data are resolved.

- PM responsibilities
  - Manage the business and financial activities of the project.
  - Responsible for contract management, budget management, subcontracting, development and oversight of schedules, preparation of monthly reports and invoices, contract modifications, preparation of the HASP, interacting with the sponsors on budgetary and schedule issues, and assisting the PI in maintaining the project on schedule and within budget.

The PM will be assisted in this role by Ms. Nicole Hyslop who will also assist the TC with administrative duties, and by Ms. Barbara Austin (STI's Office Manager) who will assist with contracts and subcontracts. The TC will be assisted in procuring instruments, obtaining expendables, setting up the measurement sites, and managing the preparation activities by Dr. Beth Wittig and Ms. Nicole Hyslop. Dr. Wittig and Ms. Hyslop will help coordinate the activities of the measurement experts and setup contractors to ensure that they stay on schedule and that the instruments are set up to be properly integrated into their respective measurement sites.

3.1.2 Field Operations Organizational Structure

The organizational structure of field operations was presented in Figure 1-3. The distribution of staff among sites is outlined below.

- Bakersfield Site (BAC)
  - A full-time operator will staff BAC throughout the annual and winter program. The Bakersfield operator will be needed almost full time at the Bakersfield site. This operator will also be available part-time for sample transport; instrument repair; calibrations, etc.; and to back up the Angiola operator.
  - Dr. Beth Wittig will serve full-time at this site. She will be the Field Manager and the primary operator of the Bakersfield anchor site. She will monitor the operations at all sites daily, review data as necessary, manage shipping and receiving, and schedule the activities of the operations and maintenance staff. She will also be available for occasional maintenance, calibration, and repair activities.
  - During the annual program, she will be assisted by a full time technician, Mr. Chris Rumm. Mr. Rumm will be available to assist in operation of the Bakersfield anchor site, to perform periodic calibrations at all sites, to help transport equipment, and to relieve other operators at other sites. During the winter, this technician’s duties will be expanded to cover the installation and operation of additional instruments at the Bakersfield site. This technician will also still be needed for other operational support throughout the network, including the maintenance of an electronic chain of custody for all anchor site and satellite filters.
- Angiola Site (ANG)
  - A full-time operator will staff Angiola throughout the annual and winter program. The Angiola operator will be needed full time at the site.

  - An additional full-time operator will be at Angiola during the winter program. This operator will be available part-time for sample transport; instrument repair; calibrations, etc.; and to back up the Bakersfield operator.
  - When winter IOPs are declared, an additional operator will be brought in to operate the MOUDI.
- San Jose (SJ4) and Sacramento (SDP) sites
  - The San Jose and Sacramento sites will be operated by their respective ARB site operators, a T&B Systems field technician, and a STI field technician. The T&B Systems field technician will perform filter changes and shipping and nephelometer calibrations at the sites on a 6th-day basis during the annual program. If available, the ARB and T&B Systems operators have agreed to assist STI personnel in performing simple emergency maintenance on the instruments or DAS.
  - The STI Field Technician will perform calibrations and maintenance on the instrumentation on a monthly basis.
  - The STI Field Technician will perform onsite emergency maintenance on the instruments if remote maintenance does not resolve the instrument issues.
- STI Petaluma Office
  - The remaining STI staff will operate from STI's home office. This office will be the focus for STI's setup operations and will provide assistance as needed for the San Jose and Sacramento sites.
  - Nicole Hyslop will assist in planning, provide site operator support, communicate with the Instrument Experts, communicate with the instrument manufacturers, and troubleshoot persistent instrument issues.
  - Mark Stoelting and Steve Ludewig will provide data system support for all sites from this office.
  - Ms. Hyslop will maintain the Bodega Bay site and assist with maintenance of the Sacramento and San Jose sites.
  - Mr. Stoelting will also provide support for the tower installations and backup field support as needed.

3.2 PROJECT DESIGN CRITERIA

3.2.1 Instrument Specifications

Tables 1-1 and 1-2 detail the instrument models used in the annual and winter phases of CRPAQS.

3.2.2 Site Selection

Refer to Section 8, Siting Criteria, in the CRPAQS Work Plan for site selection information.

3.2.3 Site Logistics

The power, space/shelter, communications, and security needs for each instrument used during the study were identified by STI and provided to Chuck McDade. The PI, TC, and STI Field Manager refined the communication needs to meet the objectives of the CRPAQS project. Security at each of the sites is considered to be important. Only CRPAQS project participants and site visitors will have access to the inside or roof of the site trailers or buildings. Roof access will be controlled from within the facility. Most instruments (with the exception of the sequential filter samplers and nephelometers) will be located inside the facility. The sequential filter samplers, nephelometers, and inlets for the other instruments will be located on the roof of the facility. The overall site logistics were determined based on these needs. Figures 3-1 to 3-5 illustrate the instrumentation and intended layout of each of the sites.

Bakersfield (Figure 3-1)

Power
- In shelter approximately 32,000W (15 20A 110V circuits, 1 20A 240V circuit)
- On roof approximately 2,100W (4 20A 110V circuits)

Space/shelter
- Total area approximately 15’ by 35’
- 7 roof inlets, 3 racks, shelf system to accommodate 4 instruments
- Conditioned environment at approximately 20-30F
- Secure

Communications
- 1 data line for data acquisition system
- 2 phone lines for fax and phone

Angiola Measurement Trailer (Figure 3-2)

Power
- In shelter approximately 32,000W (15 20A 110V circuits, 1 20A 240V circuit)
- On roof approximately 2,100W (4 20A 110V circuits)

Space/shelter
- Total area approximately 15’ by 40’
- 9 roof inlets, 3 racks, shelf system to accommodate 6 instruments
- Conditioned environment at approximately 20-30F
- Secure

Communications
- 1 data line for data acquisition system
- 2 phone lines for fax and phone

Angiola Tower (Figure 3-3)

Power
- 4 carriages at 100m require approximately (in total) 4,500W (3 20A 110V circuits)
- 1 carriage at 50m requires approximately 1,100W (1 20A 110V circuit)
- 1 enclosure at 2m requires approximately 1,100W (1 20A 110V circuit)

Space/shelter
- Carriage 1 at 100m approximately 3.5’W x 2.5’D x 4’H, 2 4’ tall racks
- Carriage 2 at 100m approximately 2.5’W x 2.5’D x 2.5’H, 1 2’ tall rack
- Carriage 3 at 100m approximately 4.5’W x 2.5’D x 3’H, 1 3’ tall rack
- Carriage 4 at 100m approximately 2.5’W x 2.5’D x 2’H, 1 2’ tall rack
- Carriage 5 at 50m approximately 2’W x 2’D x 2’H, 1 2’ tall rack
- Ground enclosure at 2m approximately 2’W x 2’D x 2’H, 1 2’ tall rack
- Conditioned environment at approximately 20-30F
- Secure – limited access to tower.

Communications
- 1 data line for data acquisition system

San Jose (Figure 3-4)

Power
- In shelter approximately 8,500W (5 20A 110V circuits)
- On roof approximately 300W (1 20A 110V circuit)

Space/shelter
- Total area approximately 6’ by 3’
- 1 roof inlet, 1 rack, shelf system to accommodate 3 instruments
- Conditioned environment at approximately 20-30F
- Secure

Communications
- 1 data line for data acquisition system

Sacramento (Figure 3-5)

Power
- In shelter approximately 8,500W (5 20A 110V circuits)
- On roof approximately 300W (1 20A 110V circuit)

Space/shelter
- Total area approximately 6’ by 3’
- 1 roof inlet, 1 rack, shelf system to accommodate 3 instruments
- Conditioned environment at approximately 20-30F
- Secure

Communications
- 1 data line for data acquisition system

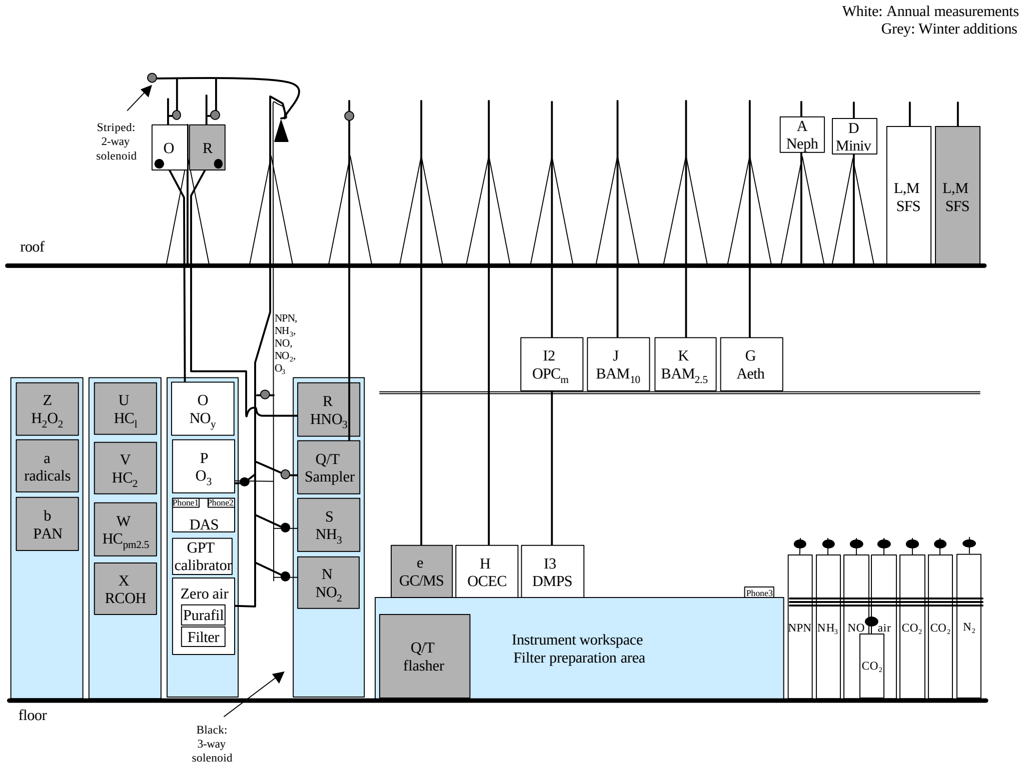

Figure 3-2a. Angiola measurement trailer layout.

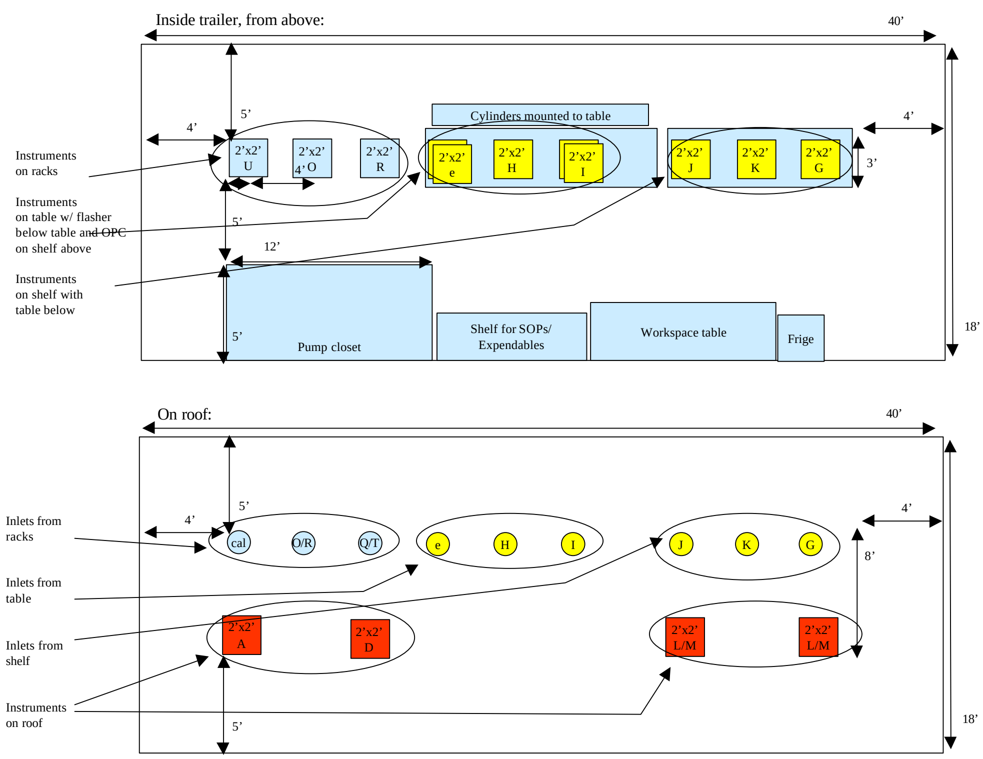

Figure 3-2b. Angiola measurement trailer layout.

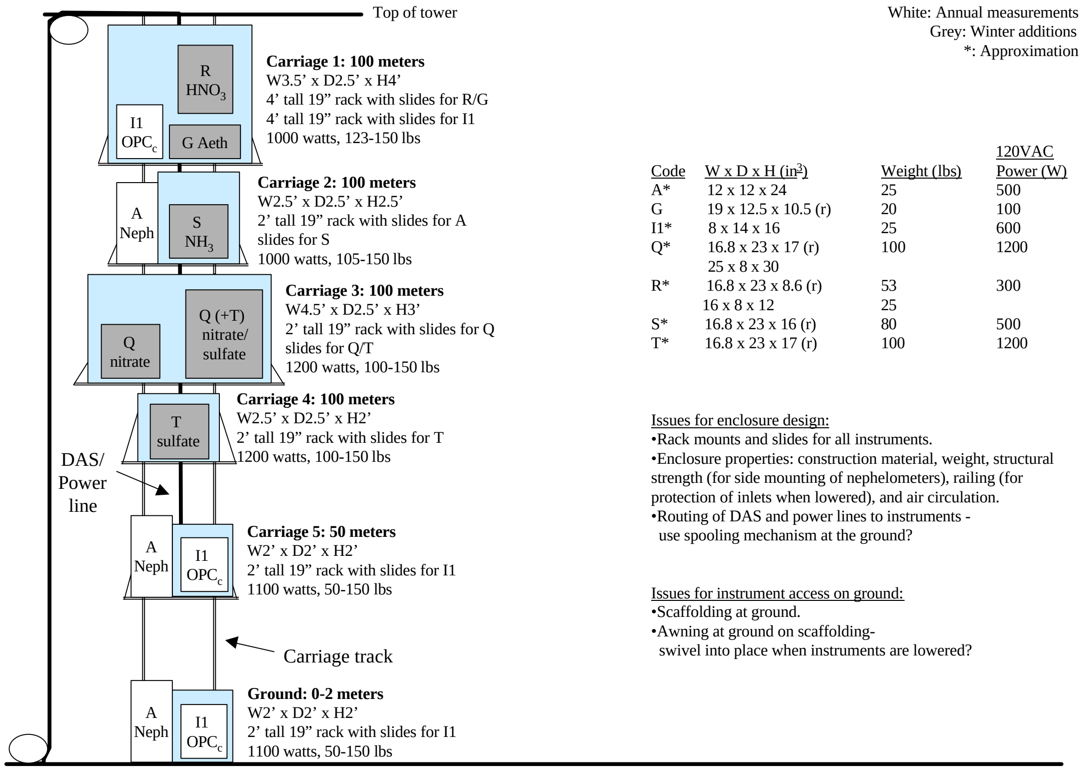

Figure 3-3. Angiola measurement tower layout.

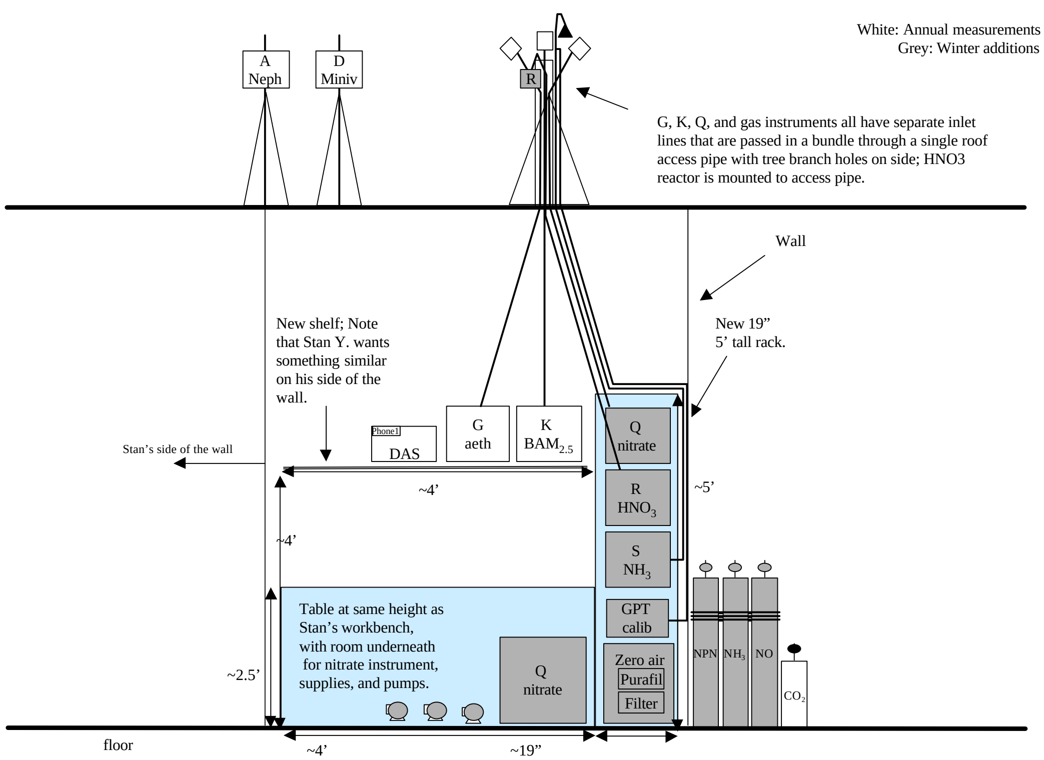

Figure 3-4. San Jose site layout.

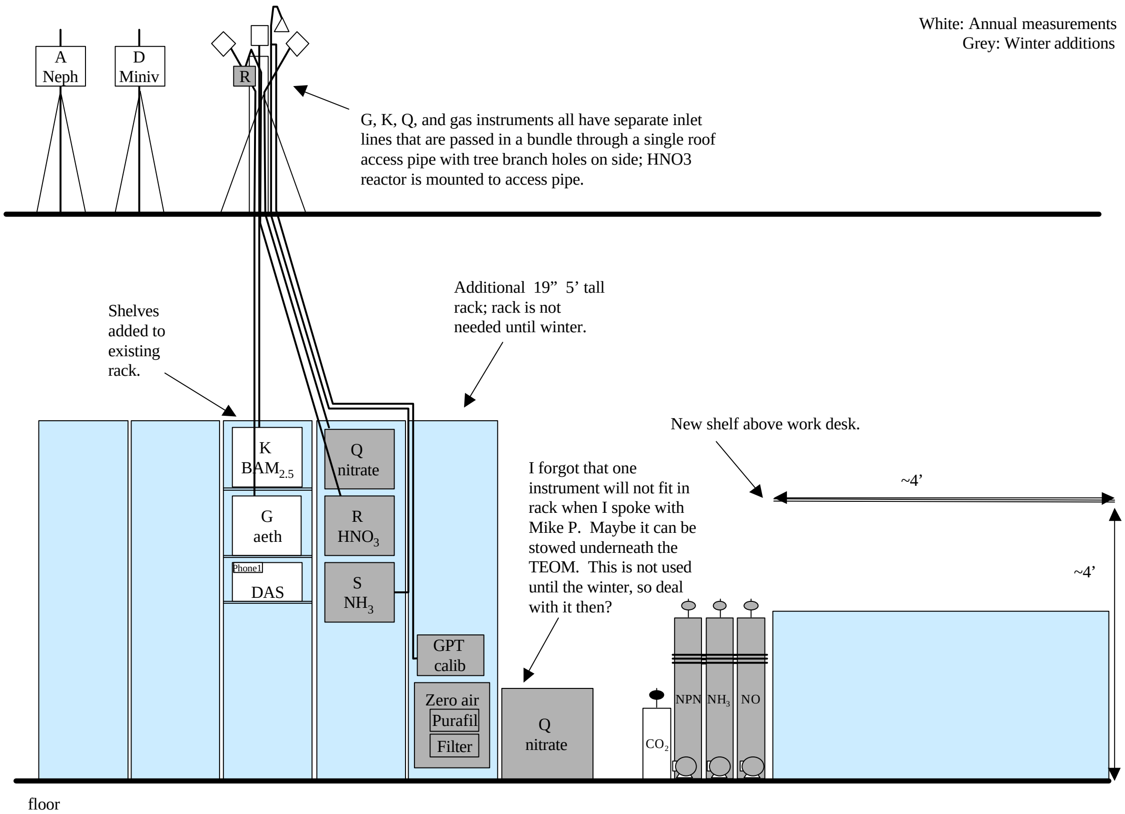

Figure 3-5. Sacramento site layout.

3.2.4 Collection of Filter Samples

STI is responsible for collection of non-continuous samples and routine maintenance of the collection equipment. Several other organizations, as noted in Table 1-1, are responsible for analysis of the samples. STI will report any relevant operating parameters (e.g. flowrates) to the organization responsible for the analysis. This data is reported in written format and is not contained in the STI database. DRI will report the data. The instrument SOPs describe the methods used by STI to collect and document the samples. Included with the SOPs are chain of custody (COC) forms that are used to track the sample media.

STI will collect only one type of non-continuous sample during the annual program and several types of non-continuous samples during the winter intensive periods. During the annual program, SFS samples will be taken at the ANG and BAC sites. As shown in **Table 3-1**, the SFS samples are collected on a daily basis for 24-hr. During the winter program, daily SFS samples will also be collected at the BTI and SNF sites. When a winter IOP is declared several more non-continuous samples will be collected and the SFS collection schedule changes. The measurements, sites, and sampling schedules for the annual and winter filter measurements are summarized in Table 3-1.

Table 2-3. Non-continuous PM measurement sampling schedules.

ID	Measured Parameter	Sites with Instrument	Sample Type	Samples Per Day	Sampling Times (PST)
L	$PM_{2.5}$ Mass & Elements (SFS with Teflon filter)	ANG, BAC, BTI, SNFH	Daily IOP	1 5	0000-2400 0000-0500, 0500-1000, 1000-1300, 1300-1600, 1600-2400
M	$PM_{2.5}$ Ions & Carbon (SFS with denuder-quartz-NaCl cellulose)	ANG, BAC, BTI, SNFH	Daily IOP	1 5	0000-2400 0000-0500, 0500-1000, 1000-1300, 1300-1600, 1600-2400
U	Light Hydrocarbons (canister & GC/FID)	ANG, BAC, BTI, SNFH	IOP	4	0000-0500, 0500-1000, 1000-1600, 1600-2400
V	Heavy Hydrocarbons (TENAX & GC/TSD/FID)	ANG, BAC, BTI, SNFH	IOP	4	0000-0500, 0500-1000, 1000-1600, 1600-2400
W	$PM_{2.5}$ Organic Compounds (Teflon coated glass fiber/PUF/XAD & GC/MS)	ANG, BAC, BTI, SNFH	IOP	2	1600-0500 [b], 0500-1600
X	Aldehydes (DNPH & HPLC)	ANG, BAC, BTI, SNFH	IOP	4	0000-0500, 0500-1000, 1000-1600, 1600-2400
c	Ion Size Distribution (MOUDI with Teflon & IC, AC)	ANG	IOP	1 - 2	0000-0500, 0500-1000, 1000-1600, 1600-2400 [a]
d	Carbon Size Distribution (MOUDI with aluminum & TOR)	ANG	IOP	1 - 2	0000-0500, 0500-1000, 1000-1600, 1600-2400 [a]
i	Denuder HNO_3 (SGS)	ANG, SNFH	IOP	5	0000-0500, 0500-1000, 1000-1300, 1300-1600, 1600-2400
j	Denuder NH_3 (SGS)	ANG, SNFH	IOP	5	0000-0500, 0500-1000, 1000-1300, 1300-1600, 1600-2400

[a] Only one or two samples of the four listed were collected on an IOP. The time periods of the collected samples were based on the episode day number and were defined by DRI.
[b] Sample collection begins the day before the IOP at 1600 PST.

Sample handling and custody procedures

- All substrates and samples will be handled with tweezers and gloves.
- When necessary, collected samples will be refrigerated at all times after sampling: during transport from the sampling site to the archiving site (Parsons), during temporary archiving at Parsons, and during transport to the DRI laboratory. Further detail on the methods of sample handling are defined in the Minivol and SFS SOPs.
- A chain of custody form (hard copy) will accompany each substrate at all stages of sampling: from setup to transport to the DRI laboratory facilities.
- An electronic log of all substrates will be maintained at the temporary archiving location (Parsons). This electronic log will detail the sampling location and time of each substrate and will allow STI and T&B Systems to maintain an accurate count of all unused and spent substrates.

3.2.5 Data Telemetry

- Continuous data collected on-site will be recorded in real-time by the DAS with the collection intervals dictated by the instrument averaging time shown in Table 1-1. Data from automatic calibration activities will be recorded during the calibrations.
- High-resolution data will be uploaded daily to the STI Data Center (STI) for review and processing and for rapid identification of instrument problems.

3.3 DATA QUALITY OBJECTIVES

- The available data quality objectives are presented in Appendix B.

4. DATA ACQUISITION

4.1 DATA RECORDING

STI designed the data acquisition systems (DAS) to be versatile enough to accommodate a wide variety of data communications and number of instruments. In addition to communications with the monitoring instruments, there are requirements for the control of calibrators, solenoid valves, and power switches. Serial data will be collected from most of the instruments, and analog outputs will be collected from a few instruments.

Compatible DAS will be used at all sites with slight variations in hardware depending on the complexity of the site. Each DAS will interface with the continuous measurement equipment in a consistent manner to record data in a consistent format. A single, consistent data interface at all sites will greatly simplify data access, processing, and troubleshooting. The DAS includes a Pentium computer with a zip drive, a hard disk sufficient to store several months of data, serial and USB ports, analog-to-digital converter boards, digital inputs, and relay controls as needed. The same basic systems with various levels of software and hardware modules will be used at all the sites.

The DAS is programmed to automatically query instruments, parse data streams received from the instruments, and control instrument functions at each site. The DAS operations are programmed in a control file referred to as the .ini file. Simply put, the ini file specifies the communications input and output necessary to obtain data from each instrument, the format of the output data from each instrument, and the calibration schedules. Some instruments must be queried for data while others automatically output data on regular time intervals. In cases where an instrument outputs a status or error signal, the ini file has been setup to identify these signals and set the operating codes (op codes) for all of the parameters from the particular instrument to indicate an error. An op code of seven is assigned to indicate an instrument error. The ini file also specifies simple unit conversions for some parameters so that all the data are compiled in a consistent set of units. The DAS automatically performs these unit conversions as the data are parsed. These conversions make it easier for the site operators to evaluate and compare the data from various instruments. The DAS does not perform any averaging functions except in the case of analog data. Analog data are collected every 1-sec and 1-min average values are calculated by the DAS.

The ini file also specifies the time and calibration file name for any automated calibration checks that are performed. Several sites run nightly zero/span checks of the O_3, NO_y, HNO_3, and/or PAN-NO_2 instruments. The calibration files contain step-by-step instructions for controlling the calibrator, pure air generator, instrument op codes, and valve positions necessary to perform the calibration. **Table 4-1** summarizes the op codes for the gas phase instruments which undergo nightly calibration checks using the calibrator.

Table 4-1. Operational codes (op codes) used in the STI database and their meanings.

NO_y, HNO_3, and PAN/NO_2 Instrument Op Codes		O_3 Instrument Op Codes	
Op Code	Meaning	Op Code	Meaning
0	okay, ambient sample	0	okay, ambient sample
1	NO span check	1	unassigned
2	GPT (NO2/NO) converter check	2	unassigned
3	NPN converter check	3	unassigned
4	NH3 converter check	4	O3 span check
5	zero air check	5	zero air check
6	matrix air check	6	unassigned
7	Instrument error	7	Instrument error
8	HNO_3 converter check	8	unassigned
9	Missing data	9	Missing data

All DAS have PCAnywhere software, which allows remote control of the DAS. Each DAS can be controlled from STI or BOC using PCAnywhere. This allows outside users to aid and instruct the site operators in operation of the DAS without visiting the site. In addition, this feature allows remote investigation and intervention at sites where there is no full-time operator, such as Sacramento Del Paso Manor and San Jose 4th Street.

Each instrument has a different data communications protocol, timing, and format. The time basis for each instrument is listed in Table 1-1. Some instruments, such as the nephelometer, have internal data logging and will be queried on a daily basis. In order to track real-time nephelometer data, the analog outputs from the instrument will be input to the DAS.

Each onsite DAS collects data from the individual instruments and generates several files on a routine basis.

1. Several 1-day serial files which contain the raw input and output for an instrument are maintained by the DAS. There is one serial file for each instrument with serial output. These files are parsed by the DAS and used to compile the 3-day running data/op code file. These files are often used for troubleshooting purposes because they document the raw output from the instruments.
2. A 1-day analog file which contains 1-sec nephelometer data is created each day by the DAS.
3. A 1-day nephelometer serial data file is automatically collected and downloaded to STI every night by the DAS.
4. A 3-day running data file, which contains a compilation of the key parameters collected from all instruments. This file is created by parsing the 1-day serial and analog files described above. The instructions for parsing these files are contained in the DAS ini file. This 3-day running data file is downloaded automatically to STI every night. Three days of data prevents the loss of data in case any problems occur over the weekend.

All these files are saved on the DAS hard drive onsite and backed up on zip disks on a monthly basis.

An example of the 3-day running data file structure is shown below. Param1, param2, and param3 are intended to represent data parameters from instruments with time bases of 1-min, 5-min, and 10-min, respectively. Thus, param1 is only reporting valid data every 5-min. During the other four minutes, an M for missing and an op code of 9, which also indicates missing, are filled into the data file. An op code is reported with each parameter in the data file.

File Header
Site ID,Date Time, param1, op code1, param2, op code2, param3, op code3, ...
BAC,12:00 value1,op code1, value 2, op code2, value3, op code3,....
BAC,12:01 value1,op code1, M,9, M,9,....
BAC,12:02 value1,op code1, M,9, M,9,....
BAC,12:03 value1,op code1, M,9, M,9,....
BAC,12:04 value1,op code1, M,9, M,9,....
BAC,12:05 value1,op code1, value 2, op code2, M,9,....
BAC,12:06 value1,op code1, M,9, M,9,....
BAC,12:07 value1,op code1, M,9, M,9,....
BAC,12:08 value1,op code1, M,9, M,9,....
BAC,12:09 value1,op code1, M,9, M,9,....
BAC,12:10 value1,op code1, M,9, M,9,....
BAC,12:11 value1,op code1, value 2, op code2, value3, op code3,....

4.2 IDENTIFICATION OF DATA

Data format requirements are outlined in Section 11.2 of the CRPAQS Field Plan.

4.3 CONTROL OF ERRONEOUS DATA

The data validation levels and flags to be used in this project are defined in Section 11.4 and 11.5 of the CRPAQS Field Plan, respectively. Erroneous data will be controlled by collecting quality control information, by performing preliminary data reviews on a daily basis, and by performing Level 1A data validation on a bimonthly basis. These activities are described in more detail in Section 8 of this document.

Recorded data which has been determined to be erroneous, rejected, superseded, or otherwise unsuited for the intended use, will be identified and flagged in the data base. Procedure- and investigator-specific validation flags will be maintained in a file. These must be translated into the common flags listed below. A translation table will be established as part of the database that associates each investigator flag with one of the following flags: 0=valid; 1=estimated; 2=calibration; 3=instrument failure; 4=off-scale reading; 5=interpolated; 6=below detection limits; 7=suspect; 8=invalid; 9=missing; a=hourly avg (45 <-> 60 minutes); b=hourly avg (<45 minutes); d=averaged data; e=zero mode; and f=blank sample. (ref: Field Plan)

Mueller (1980), Mueller et al. (1983), and Watson et al. (1995) define a three-level data validation process that should be mandatory in any environmental measurement study. Data records are designated as having passed these levels by entries in column of each data record. These levels, and the validation codes that designate them, were defined as follows:

- Level 0 (0): These data are obtained directly from the data loggers that acquire data in the field. Averaging times represent the minimum intervals recorded by the data logger, which do not necessarily correspond to the averaging periods specified for the data base files. Level 0 data have not been edited for instrument downtime, nor have procedural adjustments for baseline and span changes been applied. Level 0 review will consist of the site technician scanning the data records for evidence of malfunction during transfer at the field depots. A second review will be performed by the data manager and consist of scanning time-series plots looking for systematic problems to ensure the equipment is operating properly. Level 0 data are not contained in the CRPAQS database, although they are consulted on a regular basis to ascertain instrument functionality and to identify potential episodes prior to receipt of Level 1A data.
- Level 1A (1A): These data have passed several validation tests applied by the measurement investigator prior to data submission. The general features of Level 1A are; 1) removal of data values and replacement with –99 when monitoring instruments did not function within procedural tolerances; 2) flagging measurements when significant deviations from measurement assumptions have occurred; 3) verifying computer file entries against data sheets; 4) replacement of data from a backup data acquisition system in the event of failure of the primary system; 5) adjustment of measurement values for quantifiable baseline and span or interference biases; and 6) identification, investigation, and flagging of data that are beyond reasonable bounds or that are unrepresentative of the variable being measured (e.g. high light scattering associated with adverse weather). (ref: Field Plan)

All CRPAQS data and research products will be validated to level 1A, as defined in the CRPAQS Field Plan. Erroneous data will be controlled by performing routine maintenance on the instruments, by performing preliminary data reviews on a daily basis, and by performing Level 1A data validation on a bimonthly basis. The QC results of these activities will become part of the notes that will be “attached” to the data set within the CRPAQS overall database.

Once the data have been validated according to these practices, a preliminary report of data for each site is prepared and the Field Manager, Instrument Experts, and Technical Coordinator review copies of the report. After review, the data are accepted or returned for correction. The precision and accuracy of the data for the reporting period are reviewed and approved by the DMC prior to inclusion in one of the five deliverable data sets. Final data reports are generated after the monthly preliminary data reports have been reviewed by the field and data management staff. Once the data are in final form, they are ready for submission to the CRPAQS Data Manager.

4.4 DATA VALIDATION

Level 1A data validation will be performed on a bimonthly basis. The general features of these activities are described below.

1. Quality control information used in the data validation process:
   - Site and instrument logbook records

- Station checks
- Control charts with all daily zero, span, and maximum value data
- Instrument calibration data
- Transfer standard certification information
- Performance audit data
- Site systems audit data
- Data review and instrument log

2. Level 1A data validation steps:
   - Level 0.5 validation performed to flag invalid and outlier points
   - Extract and report QC data
   - Screen QC data for invalid calibration points
   - Calculate calibration slopes, intercepts, and baseline zeros
   - Apply zero corrections and calibrations
   - Graphically review corrected time-series plots
   - Run range checks on corrected data set to screen for remaining outliers
   - Annotate all modifications to the data set in an electronic log
   - Data that are flagged due to a power failure, calibration, audit, or other reasons, are invalidated later
   - Level 1A validation performed to review the results of Level 0.5 validation and further screen the data as discussed in the Field Plan (Fundamental chemical relationships such as pollutant ratios are also reviewed in Level 1A. Range checks are also used to detect and flag, or remove, any remaining outliers. The raw data will be retained, if needed, for future investigations.)

5. DATA MANAGEMENT

Ms. Hilary Main of STI is the Data Manager. Dr. Paul Roberts, the Technical Coordinator, will advise Ms. Main on data management issues and will oversee the data management activities.

The main data flow (for data from continuous monitors) will be from the onsite instruments to the onsite DAS to the STI data management center (DMC). Data from an individual instrument will include raw data values plus associated op codes, as described in Section 4.1. For the filter measurements, the flow rate data will be validated and then submitted to the CRPAQS Data Manager. The STI program automatically maintains one original copy of the CRPAQS database and two copies of the updated CRPAQS database. These copies of the database are generated according to the following methodology:

- Each on-site DAS uploads data to the STI DMC daily after midnight,
- 3-day running data/op code files are transferred to STI from each site,
- Transferred files are merged with the existing STI MS Access database,
- Log file of updates is maintained at STI and BOC, and
- Time series plots of all parameters are automatically generated/printed at STI, faxed to BOC, and posted on the Internet.

Several backups of this database will be maintained on a normal basis:

- Every night after polling, a full backup will be made to another computer hard drive via the network,
- A full tape backup will be made using industry standard Exabyte 8-mm backup tapes every other week with an incremental backup every week, and
- Level 1A validated data will also be written to CD-ROM each quarter for archiving.

6. RECORDS MANAGEMENT

6.1 RECORDS MANAGEMENT SYSTEM

Raw instrument data files and copies of all site documentation are stored at STI during the study. The site logbooks and instrument logbooks are kept at the monitoring stations. Hard copies of all documentation collected at each site will be sent to STI on a weekly basis. These documentation packets include all information generated during normal site operations including:

- Copies of completed site logbook pages
- Copies of completed instrument log book pages
- Copies of daily summaries for each day
- Copies of calibration forms, if a calibration was performed
- Copies of any calibration check results
- Documentation of any visits by monitoring support personnel

Send to: Cindy Green, 1360 Redwood Way, Suite C, Petaluma, CA 94954-1169

Phone: 707-665-9900

Note: When the data packet is received by STI, a telefacsimile is sent to acknowledge the receipt of the packet. If this facsimile is not received within two weeks of sending the data packet, notify STI before sending any additional data packets.

At the end of the study, the site operators will compile all of this documentation into instrument off-line summaries. These off-line summaries will be used to validate the data and prepare the data quality summary reports (DQSRs). DQSRs will be submitted for the continuous measurement instruments by STI and for the laboratory analyses by DRI. DQSRs are organized and written for the data user, to enable them to evaluate the uncertainties associated with the data and factor them into their work.

6.2 RECORDS IDENTIFICATION, AUTHENTICATION, AND INDEXING

All files and records will be labeled with their project site ID code. Files and records will be indexed according to their 3-character site ID code. Data fields in each site file will be indexed according to the date. Multiple fields will be available for each instrument. These fields will include the data value (in terms of pre-defined units) and an operational code. A single instrument often reports several parameters (e.g., the NO_y instrument will report NO concentrations, NO_y concentrations, and a status code). If available, the instrument status code can be used to alert the user to instrument malfunctions (op code). A condensed example of the data fields that might be used to report O_3 and NO_y measurements is presented in **Table 6-1**. Parameter codes will be used to identify each parameter. Operational codes will be used to identify the operational status of the instrument. Fields with no data will contain a "M" character. Each parameter has a qc code which indicates the state of the instrument and/or data.

Table 6-1. Example of the data fields that might be used to report O_3 and NO_y measurements.

Record identifier	Three-letter site identifier	Time formatted as mm/dd/yyyy hh:mm	1st O_3 parameter with defined units	O_3 operational status code (0-9)	1st NO_y parameter with defined units	NO operational status code (0-9)	2nd NO_y parameter with defined units	NO_y operational status code (0-9)	etc.	Operator Comment field (duplicated until erased)
HDR	SITE	TIME	O3	O3_OP	NO	NO_OP	NOy	NOy_OP	. . . . .	OP_COMMENT

6.3 RECORDS DISTRIBUTION AND STORAGE

All data and quality-control data will be delivered to the CRPAQS Data Manager in five quarterly submittals. The data files will meet the specifications discussed in Chapter 11 of the draft field plan (Watson et al., 1998b). Precision and validation flags will be reported with each data value. For delivery to the CRPAQS Data Manager via file transfer protocol, we will prepare data files in comma delimited text format, and with formats and names which match the specifications listed in the field plan (Watson et al., 1998b). When the CRPAQS Data Manager identifies concerns with the files or individual data values, we will review his findings, investigate our records, and provide clarification of specific suspect data. We will provide a written response to each inquiry by the CRPAQS Data Manager.

6.4 RECORDS RETRIEVAL

STI will provide an indexing system that permits information retrieval from the reviewed STI MS Access database. Data that has been reviewed to Level 1 will be presented in the database, along with the appropriate qc code. CRPAQS program management will be able to query the access database and download the results of their search via ftp.

6.5 RECORDS RETENTION

To accommodate data issues that may arise subsequent to the study, all continuous raw data, data processing documentation, and the resulting final data will be stored at STI for at least five years after the study. These data and materials can be submitted to the JPA at the end of that time, if desired. Electronic copies of the database will be kept in an off-site safe deposit box. The original site and instrument logbooks and worksheets will also be retained in an off-site safe deposit box. Two copies of this documentation will be kept at STI. One copy will be kept locked away and the other will be available for reference purposes.

7. ROUTINE CONTROLS AND PROCEDURES

Standard Operating Procedures (SOPs) for each of the measurement instruments have been written. **Table 7-1** summarizes the location in the equipment SOPs of the information requested in each of the subsections of this section.

Table 7-1. Location of QIWP Section 7 component in equipment SOP.

QIWP Section Header	Section in Equipment SOPs
7.1) Control and calibration of measurement and test equipment	k) Instrument or method calibration
7.2) Procedures	l) Sample collection, m) Handling and preservation, and n) Sample preparation and analysis OR l) Instrument operation
7.3) Establishing the adequacy of technical practices	c) References
7.4) Maintenance of equipment	o) Preventive maintenance and p) Troubleshooting
7.5) Quality of Consumables	i) Apparatus & materials
7.6) Labeling	e) Health & safety warnings
7.7) Acceptance of equipment and materials	j) Site and equipment preparation
7.8) Storage of equipment and materials	i) Apparatus & materials

8. TECHNICAL ASSESSMENT AND RESPONSE

8.1 ASSESSMENT PROCEDURES

Maintenance and regular systems checks will be performed on a routine schedule for each instrument according to their SOP. The daily data reviews will allow us to detect most problems with continuous instruments within one or two days of occurrence. On each site visit, all instruments will be inspected for problems. The Angiola and Bakersfield sites will have on-site operators who will be at the sites several times per week to perform the checks and maintenance. The San Jose and Sacramento sites will have on-site operators who will be at the sites every six days to perform the checks and maintenance. As a result, problems with Minivol samplers at other sites will be detected on site-visits before the next sampling event.

In addition, a technical assessment of the downloaded data will be performed daily to control erroneous data.

Preliminary data review steps:

- STI reviews running 2-day time series plots M-F by 10am to identify any potential problems or issues to be resolved
- STI reviews time-series plots of daily zero and span results to identify any potential problems or issues to be resolved
- BOC reviews the printed out time series plots M-F by 10am
- STI calls BOC to confirm that problems are observed mutually
- Mutually identified (non-DAS) instrument problems will be discussed with a senior scientist who will recommend the approach to be used

8.2 ASSESSMENT EVALUATION

Refer to section 12.2 of the Field Plan, which discusses field performance audits for each instrument.

8.3 ASSESSMENT RESPONSE AND FOLLOW-UP

In the event a potential problem is discovered, the following actions will be taken:

- Data reviewers:
  - Contact the STI Field Manager and the TC or PI and describe the problem
  - The information will be passed to a site operator or to a repair technician who will visit the site within 24 hours
- Site operator:
  - Contact STI Field Manager and describe problem
  - Continue to troubleshoot instrument

- Consult SOP and instrument manual first
- Consult measurement specialists and vendor technical support second
- If the problem cannot be resolved within two hours, contact STI Field Manager who will arrange for replacement

- Field Manager:
  - Arrange for initial checkout and troubleshooting when first notified
  - If not easily reparable, contact the JPA Field Manager to obtain a spare instrument
  - Arrange for a repair technician or a site operator to take the spare to the site along with a calibration system
  - Replace the malfunctioning equipment according to the SOP and perform a full calibration on the new instrument
  - Return the malfunctioning instrument to the JPA for repair

9. REFERENCES

Wittig A.E., Blumenthal D.L., Roberts P.T., Hyslop N.P. (2003) California Regional PM_{10}/$PM_{2.5}$ Air Quality Study anchor site measurements and operations. Final report prepared for the San Joaquin Valleywide Air Pollution Study Agency c/o California Air Resources Board, Sacramento, CA by Sonoma Technology, Inc, Petaluma, CA, STI-999231-2332-FR, (scheduled for publication May 2003).

APPENDIX B: DATA QUALITY OBJECTIVES

Measurement Quality Objectives - Variable NO_2 (Chemiluminescence)

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
Standard Reporting Units	All data	ppm	40 CFR, Pt 50.11	
Shelter Temperature Temperature range Temperature control	 Daily Daily	 20 to 30° C ≤ ± 2° C	40 CFR, Pt. 53.20 Vol II, S 7.1 [1/] Vol II, MS 2.3.2	Instruments designated as reference or equivalent have been tested over this temperature range. Maintain shelter temperature above sample dewpoint. Shelter should have a 24- hour temperature recorder. Flag all data for which temperature range or fluctuations are outside acceptance criteria.
Equipment NO_2 analyzer Air flow controllers Flowmeters	 Purchase specification	 Reference or equivalent method Flow rate regulated to ± 2 % Accuracy ± 2 %	 40 CFR, Pt 53.9 40 CFR, Pt 50, App F, S 2.2 EPA-600/4-75-003	
Detection Noise Lower detectable level	 Purchase specification	 0.005 ppm 0.01 ppm	 40 CFR, Pt 53.20 & 23 "	 Instruments designated as reference or equivalent have been determined to meet these acceptance criteria
Completeness Hourly Data	 Quarterly	 75 %	 40 CFR, Pt 50.11	
Compressed Gases Dilution gas (zero air) Gaseous standards	 Purchase specification Purchase specification	 Free of contaminants NIST Traceable (e.g., EPA Protocol Gas)	 EPA-600/4-75-003 40 CFR, Pt 50, App F, S 1.3 EPA-600/R-97/121	 Return cylinder to supplier. Nitric oxide in nitrogen EPA Protocol Gases have a 24-month certification period and must be recertified to extend the certification.
Calibration Multipoint calibration (at least 5 points) Convertor efficiency Zero/span check- level 1	 ≥ 1/6 months., after failure of QC check or after maintenance During multipoint calibrations 1/ 2 weeks	 Residence time ≤ 2 min Dynam. parameter ≥ 2.75 ppm-min All points within ± 2 % of full scale of best-fit straight line ≥ 96 % Zero drift ≤ ± 20 to 30 ppb Span drift ≤ ± 20 to 25 % Zero drift ≤ ± 10 to 15 ppb Span drift ≤ ± 15 %	 40 CFR, Pt 50, App F, S 1 Vol II, S 12.6 Vol II, MS 2.3.2 40 CFR, Pt. 50, App F Vol II, MS.2.3.2 Vol II, S 12.6 Vol II, MS 2.3.2 Vol II, S 12.6 Vol II, MS 2.3.2	 Zero gas and at least four upscale calibration points. Points outside acceptance criterion are repeated. If still outside consult manufacturers manual and invalidate data to last acceptable multipoint calibration or zero/span check . Replace or service converter. **If calibration factors are updated after each zero/span**, invalidate data to last acceptable zero/span check, adjust analyzer, and perform multipoint calibration. **If fixed calibration factors are used to calculate data**, invalidate data to last acceptable zero/span check, adjust analyzer, and perform multipoint calibration.

Measurement Quality Objectives - Variable NO_2 (Chemiluminescence)				
Requirement	**Frequency**	**Acceptance Criteria**	**Reference**	**Information/Action**
Flowmeters	1/3 months	Accuracy ± 2 %	Vol II, App 12	Flowmeter calibration should be traceable to NIST standards.
Performance Evaluation (NPAP) State audits	 1/year at selected sites 1/year	 Mean absolute difference ≤ 15 % State requirements	 NPAP QAPP Vol II, App 15, S 3	Use information to inform reporting agency for corrective action and technical systems audits.
Precision Single analyzer Reporting organization	 1/ 2 weeks 1/3 months	 None 95 % Confidence Interval ≤ ± 15 %	 40 CFR, Pt 58, App A EPA-600/4-83-023 Vol II, App 15, S 6	Concentration. = 0.08-0.10 ppm.
Accuracy Single analyzer Reporting organization	 25 % of sites quarterly (all sites yearly)	 None 95% Confidence Interval ≤ ± 20%	 40 CFR, Pt 58, App A EPA-600/4-83-023 Vol II, App 15, S 3	Four concentration ranges. If failure, recalibrate analyzer and reanalyze samples. Repeated failure requires corrective action.

1/ - reference refers to the QA Handbook for Air Pollution Measurement Systems, Volume II . The use of “S” refers to sections within Part 1 of Volume II. The use of “MS” refers to method-specific sections in Volume II.

Measurement Quality Objectives - Variable O_3 (Ultraviolet Photometric)				
Requirement	**Frequency**	**Acceptance Criteria**	**Reference**	**Information/Action**
Standard Reporting Units	All data	ppm	40 CFR, Pt 50.9	
Shelter Temperature Temperature range Temperature control	Daily Daily	20 to 30° C. ≤ ± 2° C	40 CFR, Pt. 53.20 Vol II, S 7.1 [1/] *Determination of Ozone by Ultraviolet Analysis (draft)*	Instruments designated as reference or equivalent have been tested over this temperature range. Maintain shelter temperature above sample dewpoint. Shelter should have a 24- hour temperature recorder. Flag all data for which temperature range or fluctuations are outside acceptance criteria.
Equipment O_3 analyzer	Purchase specification	Reference or equivalent method	40 CFR, Pt 53.9 EPA-600/4-79-057	Air flow controllers must be capable of regulating air flows as necessary to meet the output stability and photometer precision requirements. The photometric measurement of absorption is not directly related to flow rate, but may be indirectly related due to thermal or other effects.
Detection Noise Lower detectable level	Purchase specification	0.005 ppm 0.01 ppm	40 CFR, Pt. 53.20 & 23 “	Instruments designated as reference or equivalent have been determined to meet these acceptance criteria.
Completeness (seasonal) Maximum 1-hour concentration	Daily	75% values from 9:01 AM to 9:00 PM (LST)	40 CFR, Pt 50, App H, S 3	A missing daily maximum ozone value may be assumed to be less than the standard if valid daily maxima on the preceding and following days do not exceed 75 percent of the standard.
Transfer standard Qualification and certification Recertification to local primary standard	Upon receipt of transfer standard 1/3 months (if at a fixed site)	±4% or ±4 ppb (whichever greater) RSD of six slopes ≤ 3.7% Std. dev. of six intercepts ≤1.5% New slope = ±0.05 of previous	EPA-600/4-79-056 EPA-600/4-79-057 “ “	6 comparison runs that include, at minimum, 6 concentrations per comparison run including 0 and 90 ± 5% of upper range. A single six-point comparison run.
Local primary standard Certification/recertification to Standard Photometer (if recertified via a transfer standard)	1/year "	Difference ≤ ±5 % (preferably ± 3%) Regression slopes = 1.00 ± 0.03 and two intercepts are 0 ± 3 ppb	*Determination of Ozone by Ultraviolet Analysis (draft)* "	The local primary standard is a standard in its own right, but it must be repaired and recertified if the acceptance criterion is exceeded.
EPA Standard Reference Photometer recertification	1/year	Regression slope = 1.00 ± 0.01 and intercept < 3 ppb	Protocol for Recertification of Standard Reference Photometers... (TRC Environmental Document)	9 replicate analysis over 12 conc. ranges. Disagreement must be resolved. EPA Standard Reference Photometer rechecked with NIST. If OK Network STANDARD REFERENCE PHOTOMETER must be repaired.
Zero air	Purchase specification	Free of O_3 or any substance that might react with O_3 (e.g., NO, NO_2,	EPA-600/4-79-057	Return cylinder to supplier

Measurement Quality Objectives - Variable O_3 (Ultraviolet Photometric)				
Requirement	**Frequency**	**Acceptance Criteria**	**Reference**	**Information/Action**
		hydrocarbons, and particulates)		
Ozone analyzer calibration Zero/span check -level 1 Multipoint calibration (at least 5 points)	1/ 2 weeks Upon receipt, adjustment, or 1/ 6 months	Zero drift ≤ ± 20 to 30 ppb Span drift ≤ ± 20 to 25 % Zero drift ≤ ± 10 to 15 ppb Span drift ≤ ± 15% Linearity error <5%	Vol II, S 12.6 “ Vol II, S 12.6 “ 40 CFR, Pt 50, App D, S 5.2.3 EPA-600/4-79-057 S.5 Vol II, S 12.2	**If calibration updated at each zero/span**, Invalidate data to last acceptable check, adjust analyzer, perform multipoint calibration. **If fixed calibration used to calculate data**, Invalidate data to last acceptable check, adjust analyzer, perform multipoint calibration. Zero gas and at least four upscale calibration points. Check verify accuracy of flow dilution. Redo analysis. If failure persists corrective action required.
Performance Evaluation (NPAP) State audits	1/year at selected sites 1/year	Mean absolute difference ≤ 15% State requirements	Vol II, S 16.3 Vol II, App 15, S 3	Use information to inform reporting agency for corrective action and technical systems audits.
Precision Single analyzer Reporting organization	1/ 2 weeks 1/3 months	None 95% CI < ± 15%	40 CFR, Pt 58, App A EPA-600/4-83-023 Vol II, App 15, S 6	Concentration = 0.08-0.10 ppm.
Accuracy Single analyzer Annual accuracy	25 % of sites quarterly (all sites yearly)	None 95% CI ≤ ± 20%	40 CFR, Pt 58, App A EPA-600/4-83-023 Vol II, App 15, S 6	Four concentration ranges. If failure, recalibrate and reanalyze. Repeated failure requires corrective action.

[1/] - reference refers to the QA Handbook for Air Pollution Measurement Systems, Volume II . The use of “S” refers to sections within Part 1 of Volume II. The use of “MS” refers to method-specific sections in Volume II.

Measurement Quality Objectives - Variable PM10 (Dichotomous Sampler)				
Requirement	**Frequency**	**Acceptance Criteria**	**Reference**	**Information/Action**
Reporting Units	All data	µg/m^3	40 CFR, Pt 50.7	
Filter Checks				
Visual defect check	All filters	See reference	Vol II, MS 2.10.4	Discard any defective filters
Filter Integrity				
Collection efficiency	Purchase specification	99 %	40 CFR, Pt 50, App M, S 7.2	As measure by DOP test (ASTM-2988). Reject shipment.
Integrity		± 5 µg/m^3	"	
Alkalinity		< 25.0 microequivalents/gram	"	Following 2 months storage at ambient temp and relative humidity. Reject filters
Filter Conditioning				
Equilibration time	All Filters	at least 24 hours	40 CFR, Pt 50, App M, S 9.3	Repeat equilibration
Temperature range	"	15 to 30° C	40 CFR, Pt 50, App M, S 7.4	Keep thermometer in balance room and record temperature daily.
Temperature control	"	± 3° C	"	
Humidity range	"	20 to 45 % relative humidity	"	Keep hygrometer in the balance room and record humidity daily.
Humidity control	"	± 5 % relative humidity	"	
Equipment				
Sampler	Purchase specification	Reference or equivalent method	40 CFR, Pt 53.9	
Flow rate transfer standard	Purchase specification	± 2 % accuracy (NIST traceable)	40 CFR, Pt 50, App M, S7.3	
Analytical balance	Purchase specification	Sensitivity = 0.1 mg	40 CFR, Pt 50, App M, S 7.5 Vol II, MS 2.10.4	This acceptance criterion is inconsistent with other acceptance criteria for balance that are in the quality assurance handbook.
Mass reference standards	Purchase specification	NIST traceable (e.g., ANSI/ASTM Class 2)	Vol II, MS 2.10.4	
Detection Limit				
LDL	Not applicable	Not applicable	40 CFR, Pt 50, App M, S 3.1	The lower limit of the mass concentration is determined by the repeatability of filter tare weights, assuming the nominal air sample volume for the sampler.
Completeness	quarterly	75%	40 CFR, Pt 50, App K, S 2.3	
Sampler Calibration				
Flow control device	On installation, after repairs, after out-of-limits flow check	<4% difference from manufacturers spec and actual	40 CFR, Pt 50, App M, S 7.1 Vol II, MS 2.10.2	Adopt new calibration curve if no evidence of damage, otherwise replace.
Elapsed time meter	On receipt and 1/6 months	± 15 min	40 CFR, Pt 50, App M, S 7.1 Vol II, MS 2.10.1	Adjust or replace.
Flow-rate transfer Standard	Periodically	±2% over the expected range of ambient conditions	40 CFR, Pt 50, App M, S 8.2 Vol II, MS 2.10.1	Checked against NIST-traceable primary standard.

Measurement Quality Objectives - Variable PM10 (Dichotomous Sampler)				
Requirement	**Frequency**	**Acceptance Criteria**	**Reference**	**Information/Action**
Balance Calibration	1/year		Vol II, MS 2.10.4	Calibrate and maintain according to the manufacturer's recommendations.
Performance Evaluation (NPAP)	1/year at selected sites	Mean absolute difference ≤ 15%	Vol II, S 16.3	Use information to inform reporting agency for corrective action and technical systems audits
Precision Single analyzer	1/6 days	≤ 5 μg/m^3 for conc. ≤80 μg/m^3	40 CFR, Pt 50, App M, S 4.1	Both PM10 values must be > 20 μg/m^3.
Reporting organization	1/ 3 months	7% for conc. >80 μg/m^3 95% CI < ± 15%	40 CFR, Pt 58, App A, S 5.3 EPA-600/4-83-023	
Accuracy Single analyzer Annual accuracy	25 % of sites quarterly (all sites yearly)	None 95% CI ≤ ± 20%	40 CFR, Pt 58, App A EPA-600/4-83-023 Vol II, App 15, S 6	Transfer standards different then those used in calibration. Recalibrate before any additional sampling. Invalidate data to last acceptable flow check if difference ≥ 10%.
QC Checks Field calibration flow check	1/month	Percentage difference ≤ ±7 % from sampler's indicated flow rate or ≤ ± 10 % from design condition flow rate	40 CFR, Pt 50, App M, S 8.2 Vol II, MS 2.10.3	Trouble shoot and recalibrate sampler.
"Standard" filter weighing	at beginning of weighing day	± 20 μg of original weight	Vol II, S 2.10.4	Trouble shoot and reweigh.
Reweighing filters	5 exposed and 5 unexposed/day	± 20 μg of original weight	Vol II, S 2.10.4	Trouble shoot and reweigh.
Balance zero and calibration check	every fifth filter	± 4 μg at zero ± 2 μg at 10 mg	Vol II, S 2.10.4	Trouble shoot and reweigh.

1/ - reference refers to the QA Handbook for Air Pollution Measurement Systems, Volume II . The use of "S" refers to sections within Part 1 of Volume II. The use of "MS" refers to method-specific sections in Volume II.

Measurement Quality Objectives - Variable SO_2 (Ultraviolet Fluorescence)				
Requirement	**Frequency**	**Acceptance Criteria**	**Reference**	**Information/Action**
Standard Reporting Units	All data	ppm	40 CFR, Pt 50.4	
Shelter Temperature Temperature range Temperature control	Daily Daily	20 to 30° C ≤ ± 2° C	40 CFR Pt. 53.20 Vol II, S 7.1 1/ Vol II, MS 2.9	Instruments designated as reference or equivalent have been tested over this temperature range. Maintain temperature above sample dewpoint. Shelter should have a 24- hour temperature recorder. Flag all data for which temperature range or fluctuations are outside acceptance criteria.
Equipment SO_2 analyzer Air flow controllers Flowmeters	Purchase specification	Reference or equivalent method Flow rate regulated to ± 2 % Accuracy ± 2 %	Vol II, MS 2.9 " "	
Detection Noise Lower detectable level	Purchase specification	.005 ppm .01 ppm	40 CFR, Pt 53.20 & 23 "	Instruments designated as reference or equivalent have been determined to meet these acceptance criteria.
Completeness Annual standard 24-hour standard 3-hour standard	Quarterly 24 hours 3 hours	75% 75% 75%	40 CFR, Pt 50.43 " "	
Compressed Gases Dilution gas (zero air) Gaseous standards	Purchase specification Purchase specification	SO_2 free, 21 % O_2/78 % N_2, 300 to 400 ppm CO_2, ≤ 0.1 ppm aromatics NIST Traceable (e.g., permeation tube or EPA Protocol Gas	Vol II, MS 2.9.2 EPA-600/R97/121	Return cylinder to supplier. It is recommended that a clean air system be used instead of compressed air cylinders. Sulfur dioxide in nitrogen EPA Protocol Gases have a 24-month certification period for concentrations between 40 and 499 ppm and a 36-month certification period for higher concentrations.
Calibration Multipoint calibration (at least 4 points) Zero/span check -level 1 Flowmeters	Upon receipt, adjustment, or 1/ 6 months 1/ 2 weeks 1/3 months	All points within + 2% of full scale of best-fit straight line Zero drift ≤ ± 20 to 30 ppb Span drift ≤ ± 20 to 25 % Zero drift ≤ ± 10 to 15 ppb Span drift ≤ ± 15% Accuracy ± 2 %	Vol II, S 12.6 Vol II, MS 2.9.2 Vol II, S 12.6 " Vol II, S 12.6 " Vol II, App 12	Zero gas and at least three upscale points. Note: two pages from Section 2.4 (Calibration Procedures) of Vol II, MS 2.9.2 are missing from the 1994 reprinting of the QA Handbook. **If calibration updated at each zero/span**- Invalidate data to last acceptable check, adjust analyzer, perform multipoint calibration **If fixed calibration used to calculate data**. Invalidate data to last acceptable check, adjust analyzer, perform multipoint calibration Flowmeter calibration should be traceable to NIST standards
Performance Evaluation (NPAP)	1/year at selected sites	Mean absolute difference ≤ 15%	Vol II, S 16.3	Use information to inform reporting agency for corrective action and technical systems audits.

Measurement Quality Objectives - Variable SO_2 (Ultraviolet Fluorescence)

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
State audits	1/year	State requirements	Vol II, App 15, S 3	
Precision Single analyzer Reporting organization	 1/2 weeks 1/3 months	 None 95% CI < ± 15%	 40 CFR, Pt 58, App EPA-600/4-83-023 Vol II, S 16, S2	 Concentration = 0.08-0.10 ppm.
Accuracy Annual accuracy check-Reporting organization	 25 % of sites quarterly (all sites yearly)	 None 95% CI ≤ ± 20%	 40 CFR, Pt 58, App A EPA-600/4-83-023 Vol II, S 16	 Four concentration ranges. If failure, recalibrate and reanalyze. Repeated failure requires corrective action.

1/ - reference refers to the QA Handbook for Air Pollution Measurement Systems, Volume II . The use of "S" refers to sections within Part 1 of Volume II. The use of "MS" refers to method-specific sections in Volume II.

Measurement Quality Objectives- Variable $PM_{2.5}$

Requirement	Frequency	Acceptance Criteria	40 CFR Reference	QA Guidance Document 2.12 Reference
Filter Holding Times Pre-sampling Post-sampling Weighing	 all filters "	 < 30 days before sampling < 10 days at 25^{O} C from sample end date < 30 days at 4^{O}C from sample end date	 Part 50, App.L Sec 8.3 " "	 Sec. 7.9 Sec. 7.11 "
Sampling Period	All data	1380-1500 minutes or value if < 1380 and exceedance of NAAQS	Part 50, App.L Sec 3.3	
Reporting Units	All data	$\mu g/m^3$	Part 50.3	Sec. 11.1
Detection Limit Lower DL Upper Conc. Limit	 All data All data	 2 $\mu g/m^3$ 200 $\mu g/m^3$	 Part 50, App.L Sec 3.1 Part 50, App.L Sec 3.2	
Sampling Instrument Flow Rate Filter Temp Sensor	 every 24 hours of op " " "	 ≤ 5% of 16.67 ≤ 2% CV measured ≤ 5% average for < 5 min. ≤ 5^{o} C of ambient for <30min	 Part 50, App.L Sec 7.4 " "	

Measurement Quality Objectives- Variable $PM_{2.5}$

Requirement	Frequency	Acceptance Criteria	40 CFR Reference	QA Guidance Document 2.12 Reference
Data Completeness	quarterly	75%	Part 50, App. N, Sec. 2.1	
Filter				
Visual Defect Check	All Filters	See reference	Part 50, App.L Sec 6.0	Sec 7.5
Filter Conditioning Environment				
Equilibration	All filters	24 hours minimum	Part 50, App.L Sec 8.2	Sec. 7.6
Temp. Range	“	20-23^{o} C	“	"
Temp. Control	“	±2^{o} C SD over 24 hr	“	"
Humidity Range	“	30% - 40% RH or ± 5% sampling RH but >20%RH	“	"
Humidity Control	“	± 5% SD over 24 hr.	“	"
Pre/post sampling RH	“	± 5% RH	Part 50, App.L Sec 8.3.3	
Balance	“	located in filter conditioning environment	“8.3.2	
Filter Checks				
Lot Blanks	3 filters per lot	less than 15 µg change between weighings	not described	Sec. 7.7
Exposure Lot Blanks	3 filters per lot	less than 15 µg change between weighings	not described	Sec. 7.7
Lab QC Checks				
Field Filter Blank	10% or 1 per weighing session	±30 µg change between weighings	Part 50, App.L Sec 8.3	Sec. 7.7
Lab Filter Blank	10% or 1 per weighing session	±15 µg change between weighings	Part 50, App.L Sec 8.3	“
Balance Check	beginning, every 10th sample, end	≤ 3 µg	not described	Sec. 7.9
Duplicate Filter Weighing	1 per weighing session	±15 µg change between weighings	not described	Sec 7.11
Calibration/Verification				
Flow Rate (FR) Calibration	If multi-point failure	± 2% of transfer standard	Part 50, App.L, Sec 9.2	Sec 6.3
FR multi-point verification	1/yr	± 2% of transfer standard	Part 50, App.L, Sec 9.2.5	Sec 6.3 & 8.4
One point FR verification	1/4 weeks	± 4% of transfer standard	Part 50, App.L, Sec 9.2	Sec 8.4
External Leak Check	every 5 sampling events	80 mL/min	Part 50, App.L, Sec 7.4	Sec. 6.6 & 8.4
Internal Leak Check	every 5 sampling events	80 mL/min	"	Sec. 6.6 & 8.4
Temperature Calibration	If multi-point failure	± 2% of standard	Part 50, App.L, Sec 9.3	Sec. 6.4
Temp M-point Verification	on installation, then 1/yr	± 2°C of standard	Part 50, App.L, Sec 9.3	Sec. 6.4 and 8.4
One-point temp Verification	1/4 weeks	± 4°C of standard	"	Sec. 6.4 and 8.4
Pressure Calibration	on installation, then 1/yr	±10 mm Hg	“	Sec. 6.5
Pressure Verification	1/4 weeks	±10 mm Hg	“	Sec. 8.2
Clock/timer Verification	1/ 4 weeks	1 min/mo	Part 50, App.L, Sec 7.4	not described

Measurement Quality Objectives- Variable $PM_{2.5}$				
Requirement	**Frequency**	**Acceptance Criteria**	**40 CFR Reference**	**QA Guidance Document 2.12 Reference**
Accuracy				
FRM Performance Evaluation	25% of sites 4/yr	$\pm$ 10%	Part 58, App A, Sec 3.5	Sec 10.2
External Leak Check	4/yr	< 80 mL/min	not described	Sec. 10.2
Internal Leak Check	4/yr	< 80 mL/min	not described	"
Temperature Audit	4/yr	$\pm$ 2°C	not described	"
Pressure Audit	4/yr (?)	±10 mm Hg	not described	"
Balance Audit	1/yr	Manufacturers specs	not described	"
Accuracy				
Flow Rate Audit	1/2wk (automated) 4/yr (manual)	$\pm$ 4% of audit standard	Part 58, App A, Sec 3.5	Sec. 10.2
Precision				
Collocated samples	every 6 days for 25% of sites	CV $\leq$ 10%	Part 58, App.A, Sec 3.5 and 5.5	Sec. 10.2
Single analyzer	1/3 mo.	CV $\leq$ 10%	not described	not described
Single Analyzer	1/ yr	CV $\leq$ 10%	not described	not described
Reporting Org.	1/ 3 mo.	CV $\leq$ 10%	not described	not described
Calibration & Check Standards				
Flow Rate Transfer Std.	1/yr	$\pm$2% of NIST-traceable Std.	Part 50, App.L Sec 9.1 & 9.2	Sec. 6.3
Field Thermometer	1/yr	$\pm$ 0.1^{o} C resolution $\pm$ 0.5^{o} C accuracy	not described	Sec 4.2 & 6.4 “
Field Barometer	1/yr	$\pm$ 1 mm Hg resolution $\pm$ 5 mm Hg accuracy	not described	“ “
Working Mass Stds.	3-6 mo.	0.025 mg	not described	Sec 4.3 and 7.3
Primary Mass Stds.	1/yr	0.025 mg	not described	"

Measurement Quality Objectives - Variable PAMS Volatile Organic Compounds (VOC)				
Requirement	**Frequency**	**Acceptance Criteria**	**Reference**	**Information/Action**
Standard Reporting Units	All data	ppbC	TAD, July 1997	
Shelter Temperature **Temperature range**	Daily	20 to 30° C.	Vol II, S 7.1 [1/]	Instruments designated as reference or equivalent have been tested over this temperature range. Maintain shelter temperature above sample dewpoint. Shelter should have a 24- hour temperature recorder. Flag all data for which temperature range or fluctuations are outside acceptance criteria.
Detection Limit System detection limit		1 ppbC	TAD Sect 2.8 2.3	Calculation based on multiple manual or automated analysis and 40 CFR recommendations
Completeness (seasonal)	annually	85 %	TAD 2.8.1	
Calibration Multipoint retention time calibration standard	Start of analytical season	correlation coefficient $\geq$ 0.995	TAD 2.8.2.3	Triplicate analysis of multiple level propane standards over the expected sample concentration range (a minimum of three levels)
Performance Evaluation NPAP	prior to start of sampling season and twice during monitoring season	In absence of specified objectives within 25%	TAD 2.8.2.3	Useful for informing reporting agency for corrective actions and technical systems audits.
Precision Duplicate samples	once/2weeks automated 10% -manual	± 25% RSD or RPD	TAD 2.8.2.1.1	Comparison of duplicate field samples, or replicate sample analysis using manual or automated field devices.
QC Checks Retention time (RT) calibration check Canister cleaning	Weekly	Response Factor within 10% RPD of calibration curve < 10 ppbC total	TAD 2.8.2.3	Retention time checked versus annual PAMS retention time cylinder provided to each site in the program. Canister cleaning per approved methodology
Background/carryover	weekly and after calibration & RT	< 20 ppbC for both columns or <10 ppbC per column	TAD 2.8.2.3	Background testing according to TAD